Comparison Between the Quality of Finishing and Mini-Esthetics of Three Different Bracket Positioning Techniques Using the ABO Objective Grading System: A Randomized Clinical Trial

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مقارنه بين جوده اصطفاف الاسنان والنواحي التجميلية الصغرى باستخدام ثلاث تقنيات مختلفه لتحديد موضع الفصوص باستخدام نظام تصنيف الموضوعي: تجربه سريريه عشوائيه

Protocol submitted for the partial fulfillment of Masters' degree in Orthodontics

Faculty of Oral and Dental Medicine, Future University

Submitted by

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Hager Mansour Abdelbasser, BDS, will be responsible for the clinical procedures that will be carried out, sample recruitment, follow up of patients, writing the thesis, data management and results interpretation.

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All authors contributed to refinement of the study protocol.

Committees:

- Orthodontics Department Council
- College Board Committee
- Ethics Committee

Background and Rationale

Orthodontic treatment has evolved significantly over the years, requiring orthodontists to adapt their techniques and approaches. In the past, orthodontists relied on their wire bending skills, while modern orthodontics emphasizes the precise positioning of brackets. The placement of brackets plays a crucial role in determining the success of the treatment, as any errors made at the beginning can persist throughout the entire process. Improperly positioned brackets can lead to issues such as in-out disparities, tip loss, and incomplete torque expression[1].

To ensure accurate bracket placement, the facial axis point, also known as the Andrews plane, has been commonly used as a reference location for bracket placement. This point was chosen for its ease of identification and reliability[2].

In addition to the facial axis point, other reference points have been suggested for vertical bracket placement. Ricketts[3] and later Kalange[4] proposed using marginal ridges as references for the vertical position of brackets and bands. Begg's method, on the other hand, recommended placing the base of the arch-wire slot 4 mm from the incisal edge of incisors, with the bracket centered mesiodistally on the labial or buccal surface[5].

Ronald Roth introduced the second generation of brackets, incorporating adjustments to Andrews' prescription. In Roth's technique, the canine and premolar served as references for bracket height placement. McLaughlin et al[6]. emphasized the importance of precise bracket placement to effectively utilize the inherent

properties of the bracket system, suggesting specific distances from the incisal border and varying vertical placements based on tooth size.

The Smile Arc Protection (SAP) method, introduced by Thomas Pitts in 2009, aimed to achieve a harmonious smile arc by adjusting the vertical position of the maxillary incisors relative to the upper lip. The crown height of the canine tooth was used as a determinant for dental bracket placement within this method[7].

A new method called the Smile arc and marginal ridge approach (SAMRA) has been proposed to improve bracket positioning in orthodontics. This approach combines elements from previous methods and aims to consistently and reliably achieve the ideal goals of bracket positioning in three planes. It can be used for both direct and indirect bonding techniques. The bracket positioning is determined by evaluating physical or digital study models and identifying the vertical, axial, and mesiodistal planes. By incorporating these features, this approach provides a comprehensive and effective protocol for bracket positioning[8].

Beyond proper occlusion, the achievement of dental and facial esthetics is regarded as an ultimate goal of orthodontic treatment for most patients. Mini-esthetic analysis focuses on the smile framework, that is, how the teeth and lips interact during a smile, and encompasses the smile arc, smile width, buccal corridors, and incisal and gingival display, together with the harmony between the curvature of the maxillary incisors and the lower lip. Among these parameters, the vertical gingival display has been identified as a particularly significant determinant of self-perceived smile attractiveness.

Accurate bracket positioning is therefore fundamental not only for achieving a sound occlusal result but also for refined esthetic outcomes. Bracket height and angulation directly affect smile-arc consonance, incisal display, gingival exposure, and buccal-corridor appearance, because even minor vertical discrepancies in bracket placement can flatten or exaggerate the smile arc. Consequently, the choice of bracket positioning technique may influence the mini-esthetic outcome of treatment in addition to the quality of finishing, yet the two outcomes are seldom evaluated together within the same trial.

Bracket placement is recognized as one of the most influential factors affecting treatment duration and outcomes. However, the ideal bracket placement remains a topic of debate among clinicians, highlighting the ongoing pursuit for optimal techniques and approaches in orthodontic treatment[9].

There is currently no definitive evidence in the literature to suggest the existence of a single best bracket positioning technique. While various approaches have been proposed and studied, no consensus has been reached regarding the superiority of one technique over others. Each technique may have its own advantages and limitations, and the choice of bracket positioning method often depends on clinical judgment, practitioner experience, and patient-specific factors.

Statement of the problem: The variability and lack of consensus regarding the optimal system for bracket positioning in orthodontic treatment, and its consequent effect on both the quality of finishing and the mini-esthetic (smile) outcome.

Rationale for carrying out the trial: Guiding orthodontists in selecting the most appropriate system for bracket placement from either the MBT (McLaughlin, Bennett and Trevisi) Bracket Placement Chart, SAP (Smile Arc Protection) or SAMRA (Smile Arc and Marginal Ridge Approach), in order to optimize both the quality of finishing and the mini-esthetics of the smile, ultimately leading to improved treatment outcomes.

Literature Review

Several studies in the orthodontic literature compare the effectiveness of different bracket positioning techniques in terms of their quality of finishing, torque and tip control, the time required for levelling and alignment, and their effect on the mini-esthetics of the smile. The review of this research will be discussed under the following titles:

A. Effectiveness of different brackets positioning systems:

i. **Different bracket Positioning systems (MBT Bracket Placement Chart, SAP and SAMRA)**
ii. **Different bracket slot size (0.018" versus 0.022")**

B. Evaluation of effectiveness of the treatment by:

1. **Assessment of Tip and Torque using CBCT**

2. **Measuring the quality of finishing using:**

    a) **Cast Little's irregularity index (LII).**
    b) **American Board of Orthodontics (ABO)-Objective Grading System.**

3. **Evaluation of mini-esthetics (smile components: smile arc, gingival display, buccal corridor and lip line).**
4. **Methods of assessment of mini-esthetics: standardized photography and Adobe Photoshop analysis.**

A- Review on Assessment of effectiveness of different brackets positioning systems, a comparison between:

i. Different bracket Positioning systems (MBT Bracket Placement Chart, SAP and SAMRA).

Armstrong et al. (2007)[10], discussed the MBT system which incorporates various bracket prescriptions and slot sizes to accommodate different treatment needs. It aims to reduce the need for wire bending during treatment by providing brackets with pre-set angulations, tip, torque, and in-out compensations. Overall, the study suggested that the ME method may result in improved bracket placement for anterior teeth, which are crucial for achieving optimal treatment outcomes.

Thomas R. Pitts (2017)[7], Pioneered the concept of the Smile Arc Protection (SAP) technique, which focuses on preserving or enhancing the natural smile arc during orthodontic treatment. By customizing bracket positions based on individual esthetic needs, considering factors like tooth length and gingival display, orthodontists can achieve predictable and superior esthetic outcomes. This approach addresses challenges such as inappropriate bracket positioning, occlusal plane issues, incisor proclination, and irregular tooth shapes. Through optimized bracket placement and innovative techniques, orthodontists can enhance smile aesthetics while ensuring proper occlusion and function, leading to increased patient satisfaction.

El-Bokle and Ahmed (2023)[8], Conducted a study explaining the concept of the Smile arc and marginal ridge approach (SAMRA) which is a novel technique in orthodontics that aims to achieve optimal bracket positioning for improved esthetic and functional outcomes. SAMRA incorporates features from previous methods while addressing their limitations. It begins with assessing physical or digital models and demarcating vertical, axial, and mesiodistal planes. Posterior bracket positioning is determined based on a fixed distance from the marginal ridges, ensuring stable occlusion. Anterior bracket positioning considers dental and gingival anatomy to achieve a consonant smile arc. SAMRA offers a reliable and customizable method for achieving ideal alignment and esthetics with minimal need for bracket repositioning during treatment.

i.Different bracket slot size (0.018” Versus 0.022”)

Several studies have investigated the differences between 0.018-inch and 0.022-inch bracket slot dimensions in orthodontic treatment.

Epstein et al. (2002)[11], discussed the benefits of using both slot sizes within a single bracket system, highlighting that 0.018-inch brackets offer better torque control and early treatment efficiency, while 0.022-inch brackets provide more flexibility in arch-wire selection and reduced friction during space closure.

Detterline et al. (2010)[12], The study aimed to assess if there was a notable contrast in clinical outcomes between orthodontic cases treated with 0.018-inch brackets versus 0.022-inch brackets based on the American Board of Orthodontics (ABO) Objective Grading System (OGS). Analyzing 828 completed cases over a three-year period in a university graduate orthodontic clinic, treatment time and various ABO-OGS standards were used for comparison. Results indicated significantly shorter treatment durations and lower ABO-OGS scores in four categories (alignment/rotations, marginal ridges, overjet, and root angulations), as well as a lower total ABO-OGS score with the 0.018-inch brackets. After adjusting for covariates, the 0.018-inch brackets scored significantly better in both the alignment/rotations category and total ABO-OGS score.

Sifakakis et al. (2014)[13], found that using 0.018-inch brackets with stainless steel arch-wires produces higher torque (14.2 Nmm) compared to 0.022-inch brackets (9.3 Nmm). This is because the smaller slot size reduces the play between the wire and the bracket, allowing for better torque control. TMA arch-wires showed a similar trend but with lower moments due to their lower stiffness. Therefore, 0.018-inch brackets are more effective for precise torque control, especially when using stainless steel arch-wires.

Yassir A. Yassir et al. (2019)[14], found that there were no statistically or clinically relevant variations between 0.018 inch and 0.022 inch bracket slot systems in the consistency of occlusal outcomes, incisor tendency, and patient experience of care.

B. Evaluation of effectiveness of the treatment by:

1. Assessment of Tip and Torque using CBCT:

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Kumar et al. (2008)[15], compared measurements from lateral cephalograms synthesized from CBCT with those from conventional cephalometric radiographs. Thirty-one patients were imaged using both CBCT (imported in Dolphin 3D) and conventional cephalometry. Twelve linear and five angular measurements were made on both the synthesized and conventional cephalograms in a randomized fashion. The results. Unlike conventional cephalograms, CBCT is superior as it has no inherent distortion of anatomic structures.

A practical and reliable method to measure buccolingual inclination of mandibular canines and first molars is here described using Cone Beam Computed Tomography these findings was concluded after research made by **Shewinvanakitkul W. et al. (2011)[16]**

A study was made by **EL-Beialy (2018)[17],** to test the reliability and reproducibility of the different machines on CBCT, it showed that Planmeca CBCT scanner, showed excellent reliability and reproducibility in identification of landmarks.

In conclusion, CBCT cephalometric image reconstruction can be recommended as an alternative to conventional cephalograms when a CBCT volume is already available, reducing the need for additional x-ray exposure and examination expense, that is why CBCT is the method of choice for measuring torque and tip and assessing them.

2. Measuring the quality of finishing using:

a) Casts and Little's irregularity index (LII).

Arezoo Jahanbin et al. (2019)[18] used alginate impressions at the start of the treatment (T0) and for four monthly visits (T1, T2, T3, and T4). Little's irregularity index (LII) was used to assess tooth displacements, and measuring the crowding of the mandibular anterior arch, to evaluate the performance of the orthodontic brackets.

b) American Board of Orthodontics (ABO)-Objective Grading System.

Costalos et al. (2005)[19], The study outlines the implementation of the American Board of Orthodontics (ABO) objective grading system in 1999, aimed at standardizing the evaluation of posttreatment orthodontic models and panoramic radiographs. Despite the system's efficacy, there has been no examination of its applicability to digital models. This study sought to determine the accuracy and reliability of digital models in assessing final occlusions by comparing them to traditional plaster models. Using models from a postgraduate orthodontic clinic, both types were evaluated against the ABO grading system by two examiners. Results indicated no significant differences in total score and several criteria between plaster and digital models, except for alignment and buccolingual inclination. The study suggests that while digital models may be suitable for ABO model examinations, recalibration and careful consideration of certain criteria are necessary for optimal repeatability and accuracy.

Horriat et al. (2022)[20], The study aimed to assess the applicability of rating systems like the Peer Assessment Rating (PAR) and the American Board of Orthodontics Objective Grading System (ABO-OGS) to intraoral photographs. Models and photos from 50 cases were graded by four raters, with a 20% repeat assessment conducted two weeks later. Intraclass correlation coefficients (ICCs) indicated good to excellent inter- and intra-rater agreements. The mean differences between model and photo ratings were calculated, with overjet showing the highest variation. The ABO Discrepancy Index method on photographs was deemed more reliable, especially for grading pre-treatment and severe malocclusions. The study suggests

both methods can be used depending on the evaluation's purpose, considering the strengths and weaknesses of each when applied to photographs.

Evaluation of mini-esthetics (smile components):

Sarver (2001) described the smile arc as the relationship between the curvature of the maxillary incisal edges and the contour of the lower lip during a posed smile, terming it consonant when the two curves are parallel and flat or non-consonant when the incisal curve is flatter than the lower lip. He emphasized that bracket placement should be individualized to esthetic needs, since improper vertical positioning of incisor brackets can inadvertently flatten the smile arc.

Sabri (2005) described eight components of a balanced smile to be used as flexible artistic guidelines: the lip line, smile arc, upper-lip curvature, lateral negative space (buccal corridor), smile symmetry, frontal occlusal plane, and the dental and gingival components. He noted that the smile arc may be altered by excessive intrusion of the maxillary incisors, bracket positioning, and occlusal-plane canting.

Moore et al. (2005) investigated the influence of buccal-corridor width on smile attractiveness using digitally modified smiling photographs judged by laypersons. Broader smiles with reduced buccal corridors were generally rated more attractive in both sexes, and the authors recommended that excessive buccal corridors be identified during diagnosis so that they may be minimized to improve smile esthetics.

Suzuki et al. (2009) assessed how different amounts of maxillary gingival display (0, 1, 3, 5 and 7 mm) affected perceived smile attractiveness among orthodontists, maxillofacial surgeons and laypersons using a visual analog scale.

Displays of 0–1 mm were generally rated acceptable and attractive, whereas 3 mm or more were judged progressively less attractive, with specialists being more critical of gummy smiles than the general public.

Krishnan et al. (2008) quantified smile features (smile arc, buccal-corridor dimensions and a modified smile index) from standardized frontal posed-smile photographs of young adults and concluded that smile analysis should be a routine part of orthodontic diagnosis. They emphasized that orthodontists should preserve naturally consonant smile arcs, and create them when necessary, through accurate bracket positioning.

Menezes et al. (2017) examined the effect of the vertical position of the maxillary central incisors on smile perception. The most attractive smiles were those in which the central-incisor gingival margins were level with, or slightly below, the canine gingival margins, with a central-to-lateral incisal step of about 1.0–1.5 mm, highlighting the clinical importance of precise vertical bracket placement and preservation of a harmonious smile arc.

Methods of assessment of mini-esthetics (photography standardization and Adobe Photoshop analysis):

Ackerman et al. (1998) proposed a digital method for analyzing the posed (social) smile, which was selected for its reproducibility and voluntary nature compared with spontaneous emotional smiles. They recommended that photographic analysis of the relaxed posed smile become a routine part of orthodontic diagnostic records.

Fernández-Riveiro et al. (2002) described a highly standardized photographic protocol captured in natural head position using a tripod-mounted camera with a 100-mm macro lens to minimize facial distortion, paired flashes

to reduce shadows, a mirror to help achieve natural head position, and a vertical calibration scale enabling life-size measurement, thereby ensuring reproducibility of soft-tissue measurements.

Ker et al. (2008) and Chang et al. (2011) used Adobe Photoshop to isolate and digitally modify the smile region in order to evaluate ideal values and acceptable thresholds for several smile characteristics, including smile arc, buccal-corridor width and maxillary gingival display. Both studies identified smile arc and maxillary gingival display as the variables of greatest clinical significance and confirmed the suitability of calibrated digital photographic measurement for assessing mini-esthetic parameters.

Database research:

A search was performed including electronic databases (PubMed, Cochrane library, Google Scholar).

Aim of the Study

The aim of the present study is to:

Determining the Quality of Finishing using **American Board of Orthodontics (ABO)-Objective Grading System** of 3 different bracket positioning techniques.

In addition, to evaluate the mini-esthetics (maxillary gingival display, maxillary incisor display, smile arc, buccal corridor and lip line) of the 3 different bracket positioning techniques using standardized frontal photographs analyzed with Adobe Photoshop CC 2017 software, as a secondary outcome.

A-PICO format:

- **Patient/Population:**

  Young adult patients 14 to 25 years of age with mild-moderate crowding.

- **Intervention:**

  Bracket positioning using Smile Arc Marginal Ridge Approach (SAMRA)bracket System.
  Bracket positioning using Smile Arc Protection (SAP) bracket System.

- **Control/Comparator:**

Bracket positioning using Mclaughlin, Bennet and Trevisi (MBT) Bracket Placement Chart.

Outcome measure:

Outcome measure		Measure Device	Measure Unit
1ry Outcome	Quality of finishing using of 3 different bracket positioning system	- Discrepancy Index (DI) **(Appendix 1)** -Cast Radiographic Evaluation (CRE) **(Appendix 2)** -Objective grading system of American board of orthodontics (OGS-ABO)	-Measured in Millimetres
2ry Outcome	Tip and Torque Expression	CBCT	Degrees and Millimeters
2ry Outcome (Mini-esthetics)	Mini-esthetics (maxillary gingival display, maxillary incisor display, smile arc, buccal corridor and lip line) from standardized frontal photographs	Standardized photographs analyzed with Adobe Photoshop CC 2017 software	Linear measurements in millimetres; smile arc categorical (consonant / flat / non-consonant)

B-Research question:

Which bonding technique delivers the highest quality of finishing of orthodontic cases?

Objectives:

Objectives of the study Research hypothesis:

The null hypothesis of this research is that there is no difference between different bracket positioning techniques on the quality of finishing of orthodontic cases when using American Board of Orthodontics (ABO)-Objective Grading System.

Primary objective:

1. **Quality of Finishing** using of 3 different bracket positioning techniques using American Board of Orthodontics (ABO)-Objective Grading System.

Secondary objective:

1. **Anterior teeth tip and torque:** will be accessed by the principal investigator via CBCT taken before and after the completion of the levelling and alignment phase. The principal investigator will identify the landmarks, reference lines and planes, then will interpret the measurements in degrees and millimetres.
2. **Mini-esthetics:** maxillary gingival display, maxillary incisor display, smile arc, buccal corridor and lip line will be assessed by the principal investigator from standardized frontal photographs (at rest and posed smiling) taken before bonding and after completion of the levelling and alignment phase, and measured using Adobe Photoshop CC 2017 software.

Trial design:

This is Triple arm randomized clinical trial (RCT) with 1:1:1 allocation ratio (parallel arms) following CONSORT statement guidelines.

Materials and Methods

Methods (participants, interventions and outcomes)

- **Study settings:**

  Source of patients: Outpatients' clinic of Orthodontics at the Faculty of Oral and Dental medicine, Future University, Cairo governorate, Egypt.

  Dental units: Sirona C8, Germany

- **Participants:** Males and females aged 14- 25 years old.

Eligibility criteria:

A- Inclusion criteria:

- Male and female patients aged 14 to 25 years having full permanent dentition (excluding 3rd molars).
- Normal skeletal vertical dimension (SN–MP angle within 32° ± 5°).
- Angle Class I malocclusion.
- Patients having mild to moderate crowding requiring non-extraction orthodontic treatment (2–6 mm according to Graber[21]'s classification).

B- Exclusion criteria:

- Medication that might cause gingival inflammation, e.g. (Cyclosporin or Phenytoin).
- Impacted, extracted, or missing permanent teeth (except for third molars).
- Periodontal disease or parafunctional habits (i.e., Bruxism, tongue thrusting, mouth breathing, etc.…).
- History of previous orthodontic treatment.
- Craniofacial anomalies, facial asymmetries, or skeletal discrepancies.

Interventions

- **Strategies to improve adherence to intervention:**

To check compliance, adherence to oral hygiene measures.

1- Medical History Questionnaire:

For every patient, to exclude the presence of any systemic condition interfering with orthodontic treatment.

2- Clinical Examination:

Oral structures will be examined to identify caries, fracture or missing teeth. Gingival tissues will be carefully examined for any gingivitis, periodontitis, recession, or lesions.

3- Diagnosis

a) Check the potential patient to fulfil the previously mentioned inclusion criteria.

b) Every participant will be asked to sign an informed consent about the study.

Full set of records (study models, CBCT, and photos) will be taken for every patient as part of the routine procedure for treatment of patients in the clinic of the Orthodontic Department, Future University.

The patients will be randomly divided into 3 groups:

Group I: Smile Arc Protection (SAP) bracket Positioning Technique (Intervention 1).

Group II: Smile Arc Marginal Ridge Approach (SAMRA) bracket Positioning Technique (Intervention 2).

Group III: Mclaughlin, Bennet and Trevisi (MBT) Bracket Placement Chart. (Control).

Acquisition of pre-intervention records:

The following pre-treatment records will be collected from each patient:

- Pre-Treatment photographs
    - 4 Extra-Oral
    - 5 Intra-Oral
- Digital model (intraoral scan)
- Panoramic and lateral cephalometric radiographs
- Dentoalveolar CBCT scan for both jaws
- Discrepancy Index Chart

Clinical Procedure:

All Bonding procedures will be done using the Indirect Bonding Technique:

1. Performing dental prophylaxis, then obtaining intraoral digital scans of the maxillary and mandibular arches (Runyes 3D V3 pro). Examining the scans in full detail in order to avoid potential flaws that may affect the accuracy of the digital model, paying special attention to the areas corresponding to teeth. The scans were then superimposed over the CBCT volume and digitally registered using 3Shape OrthoAnalyzer software (3Shape A/S, Copenhagen, Denmark).

2. Fabricating physical working casts by 3D printing (Anycubic Mono X 4K) the digitally planned models. This procedure should be carried out judiciously so that printed casts are free from imperfections, as surface flaws will hinder brackets and tray fitting to the teeth when the tray is transferred to the oral cavity.

3. Performing virtual bracket positioning on the digital model in 3Shape OrthoAnalyzer according to the allocated bonding technique. The appropriate bracket library was selected (American Orthodontics MBT 0.018” slot prescription, with low-profile tubes for the first and second molars), and the planned positions were reviewed in dual, top, side and front views to confirm three-dimensional accuracy.

4. Fabricating transfer trays over the 3D-printed casts using a vacuum-forming machine with a 1.5 mm thick sheet (Scheu, Bioplast) thermoformed and pressed (Scheu Ministar S, 4 bar). Excess material was trimmed using scissors.

5. Teeth were prepared by etching with 37% phosphoric acid for 30 seconds, then rinsed thoroughly and dried with clean, dry air to ensure a frosty appearance. A very thin layer of sealant was applied to the etched enamel, and a small amount of adhesive was placed onto the base of each bracket.

6. The loaded transfer tray was seated over the prepared teeth, precisely positioning each bracket in its predetermined location. Adhesives were cured using a conventional LED curing light for 30 seconds. The transfer tray was then carefully removed, leaving the brackets bonded in their planned positions.
7. Before applying adhesive to the tray, the orthodontist ensures that both the tray and the base of each bracket are thoroughly cleaned. This step removes any contaminants that could compromise the bonding process.
8. Bracket Placement: With the custom setup in hand, the orthodontist precisely places each bracket onto the teeth using the cleaned transfer tray, which holds the brackets in their planned positions.
9. Bonding: Once the brackets are in place on the tray, the orthodontist applies an adhesive to the teeth and positions the tray over them. The adhesive bonds the brackets securely to the teeth in their predetermined locations.
10. Curing: After the brackets are in position, a special light or chemical is used to cure the adhesive, ensuring that it hardens and securely attaches the brackets to the teeth.
11. Excess cement will be removed using a high-speed handpiece with a finishing bur or an ultrasonic scaler is employed to ensure no cement remains around the brackets or between the teeth.
12. Wire Placement: Once the brackets are bonded, the orthodontist places the arch-wire through the brackets. This wire provides the necessary force to gradually move the teeth into their correct positions over time.

Group I (Intervention 1) Smile Arc Protection (SAP) bracket Technique:

The same steps for pre-treatment records and bracket positioning of the teeth will be established using the crown height of the canine tooth.

- The canine crown length, measured from the zenith of the gingiva to the cusp tip, will be used as a guide position for the smile arc.

- According to the height of the canines bracket positioning values will be taken from bracket chart to determine bracket heights of the other teeth from the incisal edges **Figure 2**. During placement, brackets are positioned slightly higher on the upper incisors and canines than usual. This elevated positioning is based on smile analysis to ensure that when the teeth move, they will follow a natural, harmonious curve that complements the lip line.

- Levelling and alignment will be performed.
- After levelling and aligning is completed, the following Post-treatment records will be collected from each patient:
  - Post-Treatment photographs
    - 4 Extra-Oral
    - 5 Intra-Oral
  - Digital model (intraoral scan)
  - Panoramic and lateral cephalometric radiographs
  - Dentoalveolar CBCT scan for both jaws
  - CRE Index Chart

GUIDE TO POSISTION SMILE-ARC TOM X TOM - LOWER							
GPS-A	7	6	5	4	3	2	1
11 mm	4,5	4,5	5,5	6,0	6,0	5,0	5,0
10 mm	4,0	4,0	5,0	5,5	5,5	5,0	5,0
9 mm	3,5	3,5	4,5	5,0	5,0	4,5	4,5
8 mm	3,0	3,0	4,0	4,5	4,5	4,0	4,0

GUIDE TO POSISTION SMILE-ARC TOM X TOM - UPPER							
GPS-A	7	6	5	4	3	2	1
12 mm	2,5	4,0	5,0	5,5	6,0	6,0	7,0
11 mm	2,5	3,5	4,5	5,0	5,5	5,5	6,5
10 mm	2,0	3,0	4,0	4,5	5,0	5,0	5,5
9 mm	2,0	2,5	3,5	4,0	4,5	4,5	5,0

Figure 1: Bonding chart for SAP positioning

(GPS-A): Guide position

Group II (Intervention 2) Smile Arc Marginal Ridge Approach (SAMRA) bracket Technique:

The same steps for pre-treatment records as in Group I. The SAMRA protocol was implemented entirely through a digital workflow using intraoral scans processed in 3Shape OrthoAnalyzer software (3Shape A/S, Copenhagen, Denmark) and was applied via indirect bonding.

1. Posterior Segment Bonding:

- The posterior segment will be virtually bonded first on the digital model.

2. Identification and Marking of Mesial and Distal MRs:

- The marginal ridge (MR) line (a vertical reference) is established in the posterior segment from the terminal molar to the canine tooth.

- The mesial and distal MRs will be identified and marked, then connected through the buccal surface. Which is the MR line.

3. Bracket Placement:

- Virtual bracket positioning starts with the first molar, using the Bracket Placement module of OrthoAnalyzer.

- In most patients, the end of the buccal fissure (usually at the maximum occluso-gingival convexity of the buccal surface) will be marked, and the SL (slot line) will be drawn through it parallel to the MR line.

- The distance between the MR and SL will be measured and transferred to the adjacent posterior teeth. Vertical slot positioning coincides with the green zone for ideal torque expression

Figure 2.

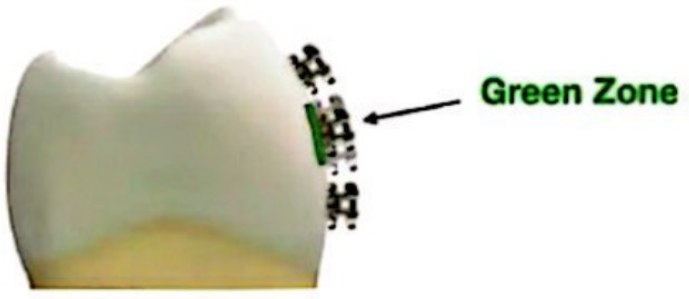


Figure 2: Green Zone for Ideal torque

- In the maxillary arch, the lateral incisor bracket will be placed at the same level from the incisal edge as the canine bracket. The central incisor bracket will be placed 0.25-0.50 mm further gingival than the lateral incisor, depending on tooth size (larger tooth, larger step).

- In the mandibular arch, the central and lateral incisors will be positioned at the same height, 0.5 mm more incisal than the mandibular canine bracket height.

- A vertical line will be drawn through the center of each tooth, perpendicular to both the MR and SL, representing the long axis or FA (facial axis). The center of the bracket should coincide with this line when checked from the occlusal plane, except for canine brackets.

- Maxillary and mandibular canine brackets should be placed 0.5-1.0 mm mesial to the A (FA-AX line intersection), depending on the mesiodistal canine width.

4. Measurement and Recording of Vertical Distances:

- After identifying the FA and SLs, the vertical distances from the cusp tips or mid-incisal edges to the intersection between the FA and SL are measured directly within OrthoAnalyzer using the software's measurement tools.

5. Replication of Bracket Positions:

- Brackets are positioned virtually on the digital model according to these measurements, with the long axis of each bracket aligned to the FA line and verified using the software multi-view feature (top, side and front views). Once the virtual setup is finalized, bracket positions are transferred intraorally using indirect bonding trays generated from the digital plan, eliminating the operator-dependent angulation errors associated with manual gauge measurement.

Levelling and alignment will be performed as in Group I

- After levelling and aligning is completed, the following Post-treatment records will be collected from each patient:
  - Post-Treatment photographs
    - 4 Extra-Oral
    - 5 Intra-Oral
  - Digital model (intraoral scan)
  - Panoramic and lateral cephalometric radiographs
  - Dentoalveolar CBCT scan for both jaws
  - CRE Index Chart

- **Group III(Control) Mclaughlin, Bennet and Trevisi (MBT) Bracket Placement Chart:**

- **Bonding of fixed orthodontic appliance using 0.018" Slot stainless steel brackets (Mini master brackets, American Orthodontics, USA)**

- MBT Bracket Placement: the clinical crown height was bisected, and the chart row whose values best matched the majority of the patient's teeth was selected to specify the bracket-to-incisal-edge distance for each tooth. Anterior bonding followed a distinctive arrangement: the maxillary central incisor and canine shared the same vertical position, whereas the lateral incisor was positioned 0.5 mm more incisal.

Bracket positioning values will be taken from the MBT chart in order to determine bracket height from the incisal edge **Figure 3**.

- Levelling and alignment for both arches using the following wire sequence:
  - ✓ Initial aligning round NiTi wires: 0.014" NiTi.
  - ✓ Alignment will be continued using: 0.016" NiTi.
  - ✓ Alignment will be continued using: 0.016"x0.022" NiTi.
  - ✓ Alignment will be continued using 0.016"x0.022" stainless steel.
  - ✓ Alignment will be continued using 0.017"x0.025" stainless steel.
  - ✓ Levelling will be completed by placing 0.017"x0.025" stainless steel, which was maintained intraorally for 3 months.
- The patients will be followed up on a monthly basis. The wires will be changed when a bigger wire size that can be fully engaged in the bracket slots.
- After levelling and aligning is completed, the following Post-treatment records will be collected from each patient:
  - Post-Treatment photographs
    - 4 Extra-Oral
    - 5 Intra-Oral
  - Digital model (intraoral scan)
  - Panoramic and lateral cephalometric radiographs
  - Dentoalveolar CBCT scan for both jaws
  - CRE Index Chart

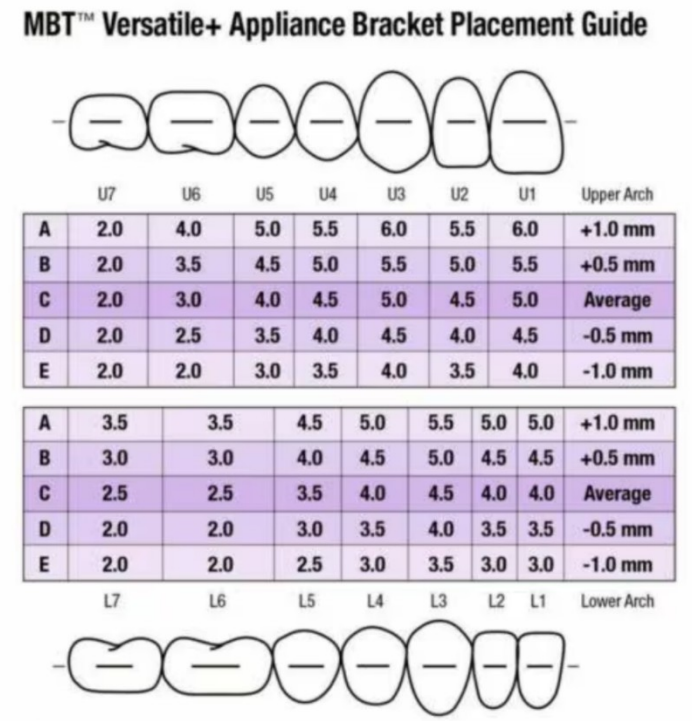


Figure 3: Bonding chart for MBT positioning

Evaluation Method:

Intra-Oral Pictures will be taken at 3 months intervals in order to observe the changes. Each sample will be evaluated using the eight parameters of the American Board of Orthodontics (ABO)-Objective Grading System according to the standard measurement using special measurement tools, such as the ABO measuring gauge, Discrepancy Index (DI) charts and Cast Radiographic Evaluation (CRE) charts. Seven parameters of the ABO Objective Grading System—namely alignment, marginal ridges, buccolingual inclination, occlusal contacts, occlusal relationships, overjet, and interproximal contacts will be evaluated using the dental casts of the patients, whereas the root angulation parameter will be evaluated using the radiographs of the patients.

CRE Measurements:

The CRE value will be obtained from the assessment and scoring of both pre-treatment and post-treatment models and panoramic radiographs. The scoring will be done according to the ABO guidelines by the use of the ABO measuring gauge **Figure 4.**

These measurements were entered into the ABO CRE assessment forms **(Appendix2)** and the total was automatically calculated electronically.

The following CRE criteria were assessed

1. Alignment and Rotations
2. Marginal ridges
3. Bucco-lingual inclinations
4. Occlusal contacts
5. Occlusal relationships
6. Overjet
7. Interproximal Contacts
8. Root angulation

Figure 4 shows the ABO measuring gauge which has been fabricated by the American Board of Orthodontics to create an objective method of measurement.10 The gauge has area markings A to D, which are explained in **Table 1**

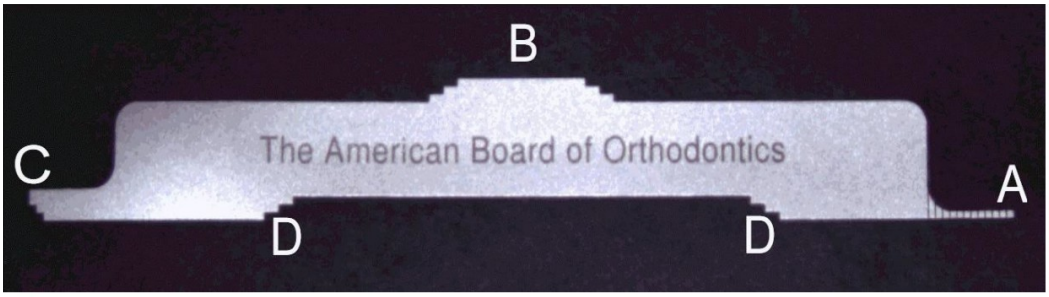


Figure 4: ABO measuring

Table 1: ABO measuring gauge markings:

AREA	CALIBRATION	EVALUATION
A	Increments of 1mm Width: 0.5mm	Discrepancies in alignment, overjet, occlusal contacts, interproximal contact and occlusal relationships
B	Steps: 1mm in height	Discrepancies in mandibular posterior bucco-lingual inclinations (Mandibular 3rd Order)
C	Steps: 1mm in height	Discrepancies in marginal ridges (2nd order)
D	Steps: 1mm in height	Maxillary posterior bucco-lingual inclinations (Maxillary 3rd order)

Table 2 encompasses a list and description of the criteria to be scored as well as the score per criteria.

Table 2: CRE criteria, their description and score

CRITERIA	DESCRIPTION[9–11]	SCORE[11]
Alignment	Horizontal evaluation of teeth **Anterior:** **Maxillary (Mx)** Incisal edges and lingual surfaces of teeth in alignment **Mandibular (Md)** Incisal edges and labial surfaces of teeth in alignment **Posterior:** **Mx:** Central grooves in alignment **Md:** Buccal cusps in alignment	Teeth all in alignment/ < 0.5mm= no points (pt) 0.5mm-1mm=1pt/ tooth > 1mm= 2 pts / tooth
Marginal ridges	**Vertical evaluation of teeth** All marginal ridges of adjacent posterior teeth should be at the same level	Each interproximal contact between posterior teeth: 0.5 -1 mm= 1 pt >1mm= 2 pt
Bucco-lingual inclinations	**Torque evaluation** No significant difference between heights of buccal and lingual cusps Md first premolars and distal cusps of second molars are not graded	0-1mm= no score 1-2mm=1pt/post tooth >2mm =2pt/post tooth
Occlusal contacts	**Assessment of functional cusps:** **Mx post teeth:** Lingual cusp **Md post teeth:** Buccal cusp Maximum intercuspation of opposing teeth Diminutive cusps excluded	≤ 1mm = 1 pt/ tooth >1mm = 2 pts/ tooth

CRITERIA	DESCRIPTION	SCORE
Occlusal relationships	Mx canine cusp tip lies between Md canine and adjacent premolar (+- 1mm range) Mesio-buccal cusp of Mx first molar should align within 1mm of mesio-buccal groove of Md first molar (Angle's Classification)[2]	<1mm = no score 1-2mm = 1 pt > 2mm = 2 pt
Overjet	**Assessment of labio-lingual relationship of Mx to Md arch** **Anteriorly**: Md incisors contact palatal surfaces of Mx anterior teeth **Posteriorly:** Md buccal cusps in central fossa of opposing Mx tooth	Articulate models, lie them flat on the back of models **Md buccal cusp:** 1mm/ less= 1pt > 1mm = 2 pts No more than 2 pts/ tooth
Interproximal spaces	**No interproximal spaces should be present.** Mesial of one surface contacts the distal surface of adjacent tooth	≤0,5mm space = no score > 0.5 – 1mm = 1 pt > 1mm = 2 pts No more than 2pts
Root angulation	Post-treatment panoramic x-ray used Roots must be parallel to each other Exclude canines for scoring	Roots parallel to each other and perpendicular to Md plane – no score Root mesial/ distal i.e. not parallel = 1 pt Root angled mesial/ distal, contacting adjacent tooth root = 2pts

Table 3: Stratification of CRE

CATEGORY	CRE SCORE	TREATMENT OUTCOME
Group A	Less than or equal to (LE)20	Excellent
Group B	Greater than (GT) 20 but LE 25	Good
Group C	Greater than 25 but LE 30	Satisfactory
Group D	Greater than 30	Unsatisfactory

Mini-Esthetics Assessment (Secondary Outcome):

As a secondary outcome, mini-esthetics will be evaluated from standardized photographs. All photographs will be obtained by the same investigator using the same camera under standardized environmental conditions (identical lighting, background and photographic settings). Patients will be positioned in natural head position, with the Frankfort horizontal plane parallel to the floor and the midsagittal plane aligned to the centre of the camera lens. Frontal photographs (at rest and posed smiling) will be taken at a fixed distance of 1.5 metres between the camera and the patient, before bracket bonding (T0) and again after completion of levelling and alignment with the 0.017″ × 0.025″ stainless steel archwire maintained for three months (T1). Each extraoral view will be obtained twice and the average value used for analysis.

Photographic standardization and materials:

The photographic set-up will include a digital camera with a macro lens (1:1 magnification), a ring flash for even light distribution, and a tripod for camera stability. A viewer (white light source) with a metric ruler will be placed behind the patient's head to eliminate shadows and to serve as a scale reference, a chair adjustable to the patient's height to obtain an accurate visual axis, and a portable mirror to help patients achieve natural head position.

Calibration and measurement:

All linear variables will be measured in millimetres using Adobe Photoshop CC 2017 software. The system will be calibrated by detecting a 10 cm reference on the ruler placed behind the patient, where the equivalent number of pixels is calculated automatically and converted to millimetres. For each participant, the pre- and post-treatment frontal smiling photographs will be zoomed to 60% and cropped before the measurements are obtained. Measurements will be performed by two calibrated, blinded assessors.

The following mini-esthetic parameters will be measured:

3. **Maxillary gingival display:** vertical amount of gingival exposure between the inferior border of the upper lip and the marginal gingival zenith of the maxillary

central incisors during smiling (in mm), assessed separately for each maxillary anterior tooth.

4. **Maxillary incisor display:** amount of visible maxillary incisor structure during smiling, measured vertically relative to the upper lip (in mm).
5. **Smile arc:** relationship between the curvature of the maxillary incisal edges and the curvature of the lower lip during posed smiling, categorized as consonant, flat, or non-consonant.
6. **Buccal corridor (lateral negative space):** linear distance between the posterior teeth and the corners of the mouth during smiling (in mm), measured on the right and left sides and averaged.
7. **Lip line:** amount of vertical tooth exposure during smiling (height of the upper lip relative to the maxillary central incisors), in mm.

Strategies to improve adherence to intervention:

- Intra-Oral pictures will be shown to the patient at 3 months intervals, to show them the changes that has occurred throughout their treatment and kept with co-supervisors.
- Improve their oral hygiene.
- Improving speech problems from the appliances.

Material Used

- American Orthodontics conventional brackets (MINI MASTER), MBT prescription (0.018” slot) for all groups, with low-profile tubes for the first and second molars.
- American orthodontics wires for all groups.
- American Orthodontics O – Ties for all groups.

- Intraoral scanner (Runyes 3D V3 pro) and 3Shape OrthoAnalyzer software (3Shape A/S, Copenhagen, Denmark) for the digital workflow.

- 3D printer (Anycubic Mono X 4K) for fabrication of working casts, and a vacuum-forming machine with 1.5 mm Bioplast sheets (Scheu) and Scheu Ministar S for transfer-tray fabrication.
- Planmeca CBCT scanner (90 kV, 8 mA, medium FOV) for pre- and post-treatment imaging.
- Digital camera with macro lens, ring flash and tripod, with a viewer/light source and metric ruler, a height-adjustable chair and a portable mirror for standardized photography, and Adobe Photoshop CC 2017 software for image calibration and mini-esthetic measurements.

Outcomes:

- **Primary outcome:**
- **Quality of Finishing** will be assessed by the principle investigator using American Board of Orthodontics (ABO)-Objective Grading System comparing DI before treatment to CRE After Treatment

- **Secondary outcomes:**

1. Anterior teeth tip and torque: will be assessed by the principle investigator via CBCT taken before and after the completion of levelling and alignment. The principal investigator will identify the landmarks, reference lines and planes, then will interpret the measurements in degrees and millimetres.

2. Mini-esthetics: maxillary gingival display, maxillary incisor display, smile arc, buccal corridor and lip line will be assessed by the principal investigator from standardized frontal photographs (at rest and posed smiling) taken before bonding and after completion of levelling and alignment, measured using Adobe Photoshop CC 2017 software.

Participant timeline:

1. The principle investigator will screen the potential patients through careful clinical examination of patients at the orthodontic department, Faculty of Oral and Dental Medicine, Future University.

2. All recruited patients should fulfil the previously mentioned inclusion and exclusion criteria.

3. Every participant will be asked to sign an informed consent before the beginning of the study.

4. After patient's enrolment, each participant will be asked for pre intervention records to ensure proper diagnosis T0.

- Pre-Treatment photographs
    - 4 Extra-Oral
    - 5 Intra-Oral
- Digital model (intraoral scan)
- Panoramic and lateral cephalometric radiographs
- Dentoalveolar CBCT scan for both jaws
- Discrepancy Index Chart

5. The principle investigator will randomly allocate the patients to the groups.

6. Indirect bonding of the brackets will be carried out according to the allocated group.

7. The active intervention is to achieve proper levelling and alignment of the upper and lower arch.

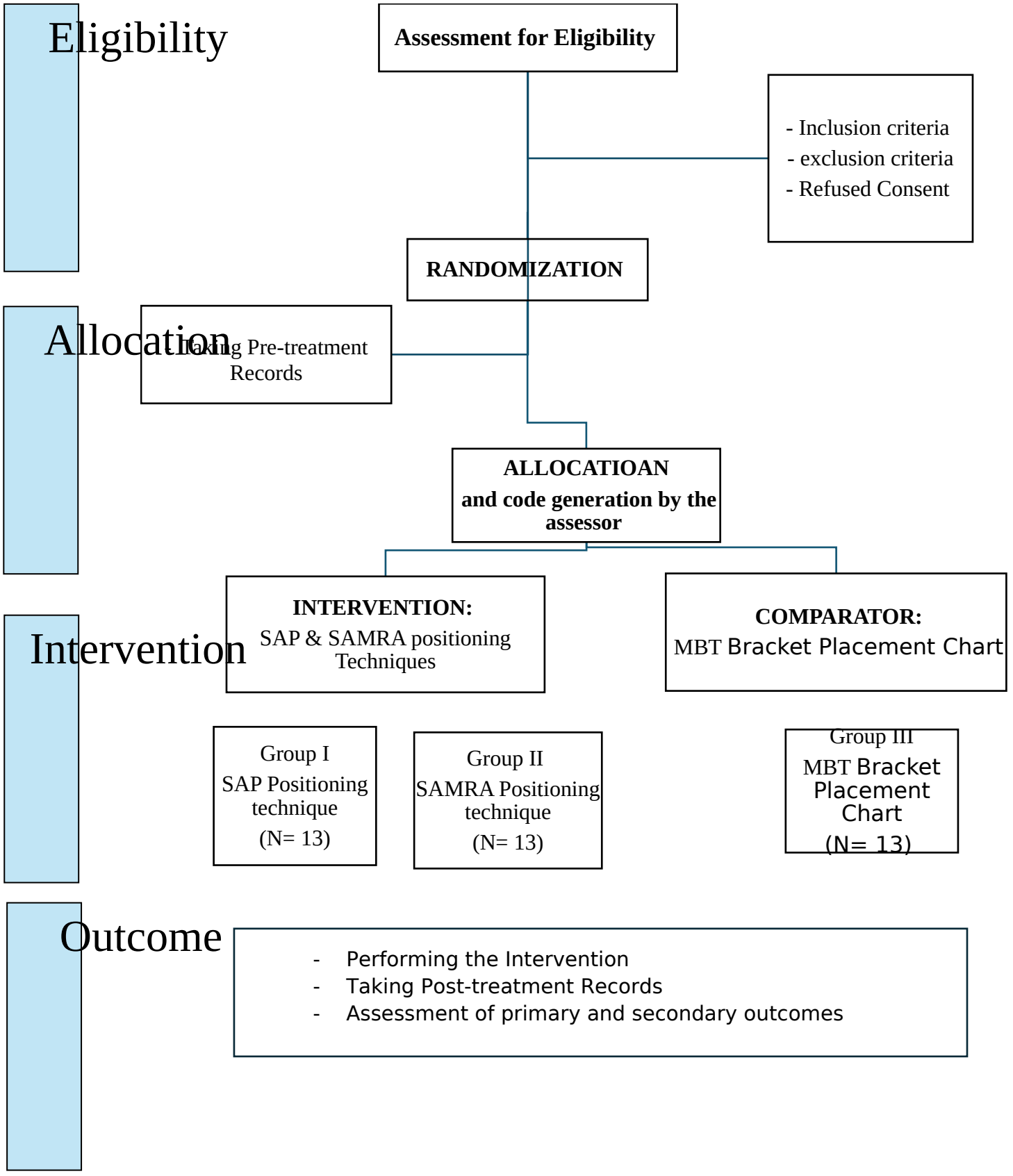
8. Each patient will come every 4 weeks for follow up visit, for activation.

9. After completion of levelling and alignment, the principle investigator will take post levelling and alignment records for each participant T1.

10. The principle investigator will continue the normal treatment and achieve proper finishing for every patient after the end of the study.

11. Post treatment records will be taken after debonding of the brackets T2.

- Post-Treatment photographs
    - 4 Extra-Oral
    - 5 Intra-Oral
- Digital model (intraoral scan)
- Panoramic and lateral cephalometric radiographs
- Dentoalveolar CBCT scan for both jaws
- CRE Index Chart


Eligibility
Assessment for Eligibility
- Inclusion criteria
- exclusion criteria
- Refused Consent
RANDOMIZATION
Allocation
- Taking Pre-treatment Records
ALLOCATIOAN
and code generation by the assessor
Intervention
INTERVENTION:
SAP & SAMRA positioning Techniques
COMPARATOR:
MBT Bracket Placement Chart
Group I
SAP Positioning technique
(N= 13)
Group II
SAMRA Positioning technique
(N= 13)
Group III
MBT Bracket Placement Chart
(N= 13)
Outcome
- Performing the Intervention
- Taking Post-treatment Records
- Assessment of primary and secondary outcomes

Sample size calculation:

A power analysis was designed to have adequate power to apply a statistical test of the null hypothesis that there is no difference would be found between different tested groups regarding clinical outcomes using the ABO-OGS. By adopting an alpha (α) level of (0.05), a beta (β) level of (0.2) (i.e. power=80%) and a large effect size (f) of (0.525) derived from a comparable published study; the total required sample size (n) was found to be (39) cases (i.e. 13 cases per group). A 1:1:1 allocation ratio was used to ensure equal numbers across the three intervention arms, in line with the parallel three-arm trial design. Sample size calculation was performed using R statistical analysis software version 4.3.2 for Windows.

Total sample size = 13 per each group

Recruitment strategy:

The principal investigator will recruit the patients from the clinic of Orthodontic department, Faculty of Oral and Dental Medicine - Future University.

Screening of patients will continue until the total number of participants for the study is collected.

Randomization:

Patients were randomly allocated into one of the three groups using Research Randomizer (www.randomizer.org), a free online randomization service. A sequence of random numbers was generated by entering the total number of patients in the first field and selecting the number of groups (three). The output provided a randomized assignment list which was used to allocate each patient to either Group (SAP), Group (SAMRA), or Group (MBT). The generated list was kept with the co-supervisor (H.D.), concealed from the principal investigator, and allocation was revealed only on the day of each patient's intervention.

Allocation concealment mechanism:

Following generation of the random allocation sequence, each allocation number was placed in a separate opaque, sealed envelope. The envelopes were identical in appearance and were prepared by the co-supervisor (H.D.), who was not involved in patient recruitment, clinical intervention, or outcome assessment. The randomization codes were kept concealed from the principal investigator until the day of each patient's scheduled intervention.

Implementation:

Following sequence generation, the randomization list obtained from Research Randomizer was securely stored with the co-supervisor and kept concealed from the principal investigator. Upon enrolment of each patient, the co-supervisor was informed of the patient's name, and the corresponding group allocation was retrieved from the randomization list. The principal investigator was then informed of the assigned group only on the day of the scheduled intervention. Assignment occurred before the levelling and alignment stage.

Blinding:

- ✓ **Blinding of the operators:** Blinding of the operators was not feasible during the application of interventions or follow-up visits due to the nature of the procedures. The co-supervisor was responsible for assigning subjects to their respective intervention groups according to the concealed allocation list. The principal investigator was responsible for appliance activation at follow-up visits, as well as the acquisition of intraoral scans and digital models.**Blinding of the outcome assessors:** This study was conducted as a single-blind trial, in which the outcome assessors were blinded to group allocation. All patient identifiers were removed from pre- and post-treatment radiographs and digital models prior to assessment. Two calibrated assessors then independently and blindly performed all measurements and analyses.

Data collection, management and analysis:

The data collection methods will be done by data recording the patient history and personal data will be collected by the operator through diagnostic chart.

Plans to promote participant retention and complete follow-up:

Telephone numbers of all enrolled patients will be recorded as a part of the written consent. All patients will be given a phone call at the time of the predetermined follow-up.

Data monitoring:

All data will be entered and saved electronically. Patient files are to be stored in numerical order and stored in secured file. Data will be encrypted using a password. All data will be maintained in storage for 1 year after completion of the study.

Statistical Analysis:

Categorical data will be represented as frequencies and percentages and will be analyzed using chi-square test. Numerical data will be explored for normality by checking the data distribution and by using Shapiro-Wilk's test. If the data was found to be normally distributed, it will be presented as mean and standard deviation values and one-way ANOVA followed by Tukey's post hoc test will be used for the analysis. If the assumption of normality was found to be violated; the data will be presented as median and interquartile range values and will be analyzed using Kruskal-Wallis's test followed by Dunn's post hoc test with Bonferroni correction. The significance level will be set at $p<0.05$ for all tests. Statistical analysis will be performed with R statistical analysis software version 4.3.2 for Windows.

Assessors Reliability:

Two calibrated assessors will perform all outcome measurements (ABO-OGS scoring on dental casts and panoramic radiographs, and CBCT-derived crown angulation and inclination measurements). Calibration will be carried out before data collection on five reference cases not included in the trial sample, with the requirement of achieving an Intraclass Correlation Coefficient (ICC) ≥ 0.80 against a senior examiner. Intra-examiner reliability will be assessed by re-measuring 20% of randomly selected cases two weeks after the initial measurement. Inter-examiner reliability will be assessed by independent, blinded measurement of the same subset by both assessors. Reliability will be quantified using two-way random-effects, absolute-agreement ICC values, with ICC ≥ 0.75 interpreted as good reliability and ICC ≥ 0.90 as excellent reliability. Discrepancies exceeding pre-defined thresholds (1 mm for linear measurements, 2° for angular measurements) will be re-evaluated jointly with the supervisor.

Harms:

Any temporary or permanent adverse effect will be recorded and documented.

Auditing:

Auditing of the study design will be done by the Ethics Committee, Faculty of Oral and Dental medicine- Future University.

Research ethics approval:

This protocol and the template informed consent form will be reviewed by the Ethics Committee of Scientific Research –Faculty of Oral and Dental Medicine- Future University.)

Protocol amendments:

Any modification to the protocol which may have an impact on the conduct of the study, potential benefit of the patient or may affect patient safety will require a formal amendment to the protocol. Such amendment will be agreed upon by the Council of Orthodontic Department.)

Consent:

The entire procedure will be explained to the patients and a written consent will be obtained.

Confidentiality:

All study-related information will be stored securely.

Declaration of interests:

If there will be any conflict of interest, it will be declared.

Ethics and Dissemination policy:

The study results will be published as partial fulfillment of the requirements for Master degree in orthodontics, Faculty of oral and dental medicine, Future University in Egypt.

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Appendix 1

Discrepancy Index (DI) chart:

1- Overjet

≥ 0 to < 1 mm (edge-to edge)	=	1 point
≥ 1 to ≤ 3 mm	=	0 point
> 3 to ≤ 5 mm	=	2 points
> 5 to ≤ 7 mm	=	3 points
> 7 to ≤ 9 mm	=	4 points
> 9 mm	=	5 points
Negative	=	1 pt/mm/tooth
Total	=	5

2- Overbite

> 0 to ≤ 3 mm	=	0 point
> 3 to ≤ 5 mm	=	2 points
> 5 to ≤ 7 mm	=	3 points
> 100% overbite	=	5 points
Total	=	5

3- Anterior open bite

0 mm (edge-to-edge)	=	1 point/tooth
Open bite (> 0 mm)	=	1 point/addl. mm/tooth
Total	=	0

4- Lateral open bite

≥ 0.5 mm (maxillary posterior tooth)	=	2 points/mm/tooth
Total	=	0

5- Crowding

0 - 1 mm	=	0 point
1.1 - 3 mm	=	1 point
3.1 - 5 mm	=	2 points
5.1 - 7 mm	=	4 points
> 7 mm	=	7 points
Total	=	1

6- Occlusal relationship (Angle classification)

Class I up to end to end	=	0 point
End to end Class II or III	=	2 points per side
Full cusp Class II or III	=	4 points per side
Beyond Class II or III	=	+ 1 addl. point/mm/side
Total	=	8

7- Lingual posterior crossbite

buccal cusp > 0 mm to lingual	=	1 point per maxillary tooth
Total	=	0

8- Buccal posterior crossbite

palatal cusp > 0 mm to buccal	=	2 points per maxillary tooth
Total	=	0

9- Cephalometric measurements

ANB ≥ 6° or ≤ -2°	4 points	=	4
For each degree > 6° or < -2°	+ 1 point	=	0
SN-MP ≥ 38°	2 points	=	0
For each degree > 38°	+ 2 points	=	0
SN-MP ≤ 26°	1 point	=	0
For each degree < 26°	+ 1 point	=	3
$\bar{1}$ to MP ≥ 99°	1 point	=	1
For each degree > 99°	+ 1 point	=	7
Total		=	15

10- Other conditions

Supernumerary	1 point/tooth	=	0
Ankylosis of permanent teeth	2 points/tooth	=	0
Anomalous morphology	2 points/tooth	=	0
Impaction (except for 3rd molars)	2 points/tooth	=	0
Midline discrepancy ≥ 3 mm	2 points	=	0
Missing teeth (except 3rd molars)			
» Non-congenital	1 point/tooth	=	0
» Congenital	2 points/tooth	=	0
Spacing (≥ 0.5 mm on ≥ 4 teeth)	2 points/arch	=	0
Diastema Mx. central incisor ≥ 2 mm	2 points	=	0
Tooth transposition	2 points/tooth	=	0
Skeletal asymmetry (non-surgic.)	3 points	=	0

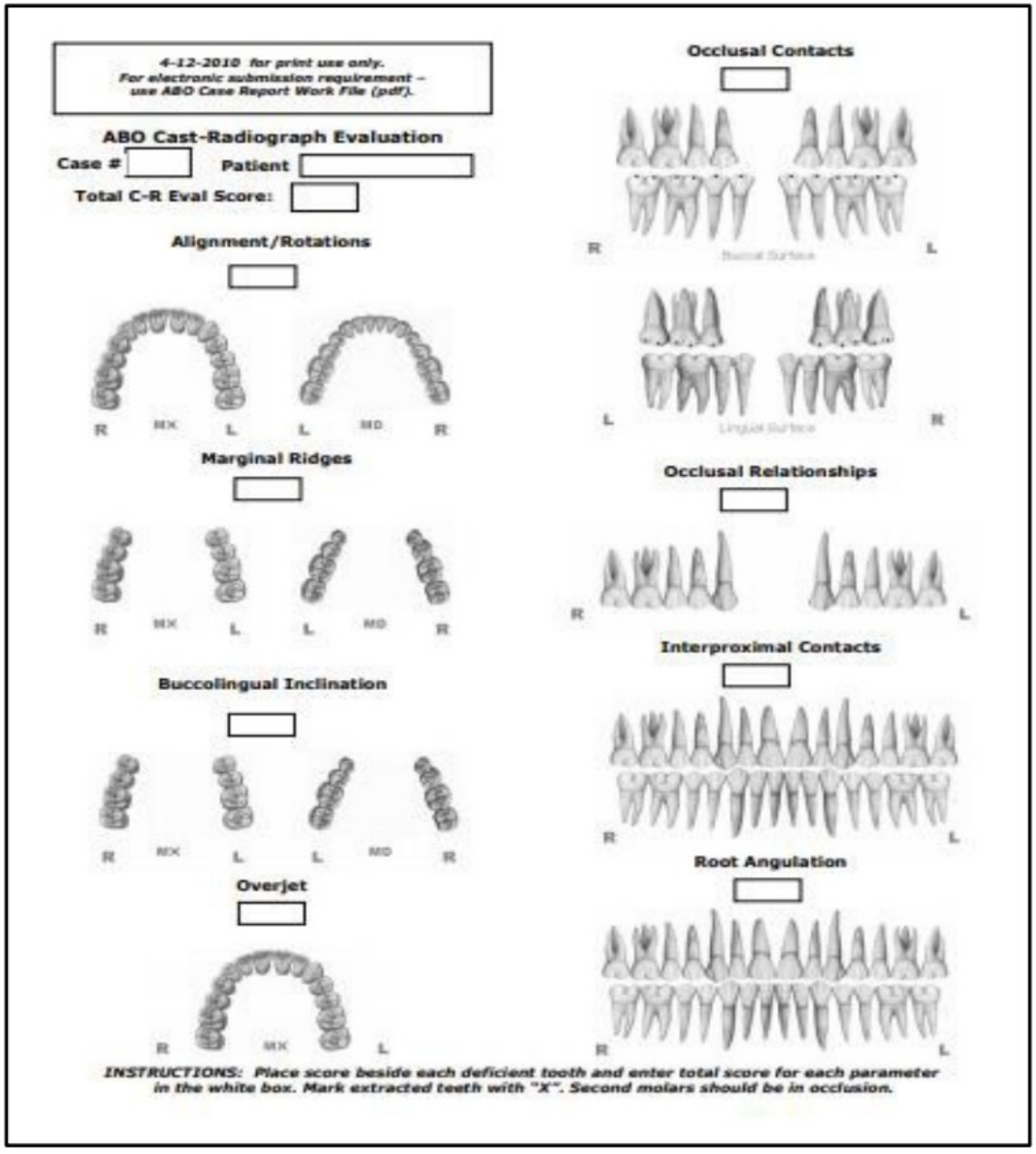
Additional treatment complexities	2 points for each occurrence
1-	
2-	
3-	
4-	
5-	
Total =	

Total DI	=	34

Note: Shaded cells must be preserved to evaluators' notes.

Appendix 2

Cast Radiographic Evaluation (CRE) chart:



Alignment	First Order (horizontal) alignment of teeth
Marginal ridges	Second Order (vertical) alignment of teeth
Bucco-lingual inclination	Third Order positions of the molars
Overjet	Buccal and anterior segments