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Face bow transfer

A graduation project submitted to the College of Dentistry, the University of Baghdad in partial fulfillment of the requirement for a degree Of B.D.S.

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Supervisor certificate

This is to certify that the organization and preparation of this project have been made by the graduate student Alaa Riyadh Fadhil under my supervision at the College of Dentistry/University of Baghdad in partial fulfillment of the requirement for the degree of B.D.S.

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Dedication

I dedicate this research to my family especially my mother, who was the biggest supporter for me throughout my years of studying. Thank you mom for everything.

Acknowledgment

First of all, I thank **God Almighty**, who has blessed me with wisdom, patience, and willpower to reach this level in my life.

I would like to thank ***Professor Dr. Raghad Al Hashimi***, the dean of the College of the Dentistry, University of Baghdad for providing me the opportunity to complete my work.

Also, I express my thanks to Prof. ***Dr. Ali H. Al-Bustani*** Assistant Dean for Scientific Affairs and students of the College of Dentistry-University of Baghdad for his continuing support to complete this work.

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Introduction

In prosthodontics, while we attempt to restore or replace missing teeth, it becomes imperative to mount patients' maxillomandibular relation on an articulator with maxillary and mandibular casts, oriented to the hinge axis, for laboratory procedures **(Murakami et al., 2019).**

Face-bow is an instrument used to record the spatial relationship of the maxillary arch to some anatomic reference point or points and then transfer this relationship to an articulator; it orients the dental cast in the same relationship to the opening axis of the articulator **(Murakami et al., 2019).**

The maxilla is a part of the cranium and is a fixed entity. When the teeth of both jaws come in contact, the maxilla becomes related to the mandible so that the entire craniomaxillary complex is articulated with a moving bone, which is the mandible. The opening movement to bring the jaw from occlusal to rest position is almost a pure hinge movement. Here the mandible moves in an arc of a circle with a definite radius from the temporomandibular joint. This path of the condyle is determined by the curvature of the condylar head and the curvature of the glenoid fossa **(Rathee, Malik and Jyotirmay, 2014).**

Prosthodontic rehabilitation with indirect restorations that are in harmony with the patients' masticatory system in a minimum amount of time and effort is very crucial **(Walker et al., 2008).**

However, results of clinical studies made to compare the patient response to variations in denture techniques failed to show any significant differences between a complex technique involving hinge axis location, for a face-bow transfer to the articulator, and a standard technique without a face-bow and with an arbitrary mounting **(Zizelmann et al., 2012).**

Aims of the study

- The benefits of using facebow in the prosthodontics field.
- Technique for transferring the location of a digitized cast from the patient to a virtual articulator.
- Using facebow transfer in prosthodontic clinic.
- Exploring recently used advances in facebow transfer.

Chapter One

Review of the literature

1.1. Overview

Restorative dentistry always requires a series of appropriate clinical laboratory procedures and a reliable armamentarium of instruments for successful treatment given to the patient. Every single phase of these procedures should be executed with accuracy, skill, and speed to comply with the biological conditions of the patient. A prosthesis that has the closest resemblance to the oral cavity should also harmonize with the various jaw movements which are determined by the anatomical form of the temporomandibular joint **(Chow, Clark and Cooke, 1985).**

Complete denture prosthesis involves important factors in the control of the operator. The operator is concerned with the determination of the incisal guidance, the plane of orientation, and condylar guidance. The maxilla is a part of the cranium and is a fixed entity. When the teeth of both jaws come in contact, the maxilla becomes related to the mandible so that the entire cranio-maxillary complex is articulated with a moving bone, which is the mandible. The hinge axis is defined as an imaginary line passing through the two mandibular condyles around which the mandible rotates without translatory movement **(Nazir et al., 2012).**

The face bow helps to relate the arc of closure or hinge axis of the mandible to the cranium. It helps to record the opening and closing path of movement. Face bow transfer is an integral part of analyzing and studying the occlusion **(Dudani and Hindocha, 2014).**

1.2. Benefits of facebow

- It permits a more accurate use of rotational points for the arrangement lateral of teeth.
- It aids in securing the anteroposterior positioning of the cast concerning the condyles. A correct horizontal plane is established
- The facebow transfer record is an integral part of analyzing and studying the occlusion of the natural teeth.
- Therefore, the incisor plane is also properly established, and finally, it helps in the vertical positioning of the casts in articulators.
- It should be used for mounting the upper cast on any articulator that has a fixed axis of opening **(Hangai et al., 2008).**

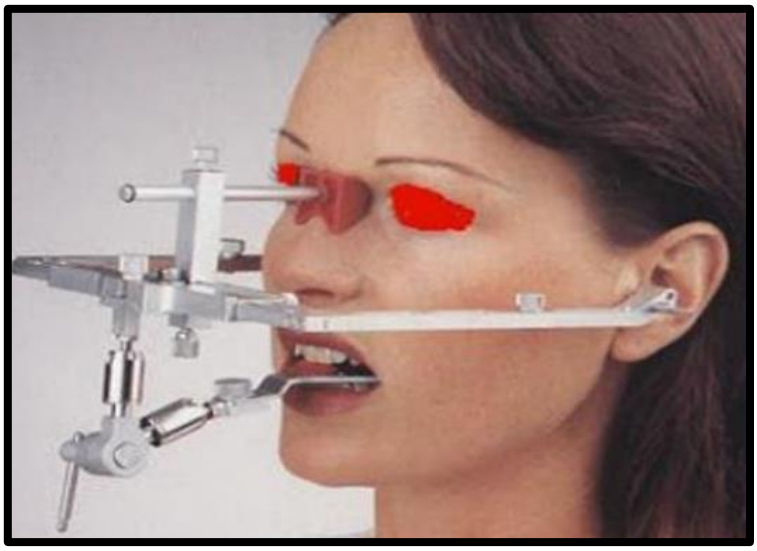

Figure (1-1): A facebow **(Hangai et al., 2008).**

1.3. Classification of facebow

1.3.1. Arbitrary Facebow

The arbitrary type of facebow is approximately located on the hinge axis. It is commonly used for complete denture construction. This type of face bow is generally located on the true Hinge axis within a range of 5 mm. It uses arbitrary or approximate points on the face as the posterior points and condylar rods are positioned on these points. It is further classified as fascia and earpiece type of facebow **(Hatim and Alubaid, 2012).**

1.3.2.1. Fascia Type

The fascia type of face bow utilizes approximate points on the skin over the TMJ as the posterior reference points. These reference points are located by measuring certain anatomical landmarks on the face. While using the facia facebow, the center of the condyle is arbitrarily located on the side of the face 11-13 mm anterior to the tragus on a line connecting the superior border of the tragus and the outer canthus of the eye. It has a disadvantage that it is placed on the skin which is movable and so there is a tendency for the condylar rods to displace. It also requires an assistant to hold the face bow in place **(A. H. Elsayed, I. Fayad and R. Z. Alkholy, 2018).**

1.3.2.2. Earpiece type

These facebow uses the external auditory meatus as an arbitrary reference point which is aligned with earpieces similar to those on a stethoscope. It helps to accurate relationships for most diagnostic and restorative procedures. It has the advantage that it is simple to use, and does not require measurements on the face. It is as accurate as other face bows and it provides an average anatomic dimension between the external auditory meatus and horizontal axis of the mandible.

Earpiece facebow is further classified as:

- Spring bow type.
- Whip mix face bow **(L and Mattoo, 2017).**

1.3.3. KINEMATIC FACE BOW

A kinematic facebow is used to determine and locate the exact hinge axis. This facebow is generally used in the fabrication of FPD and FMR cases. The hinge axis of the mandible can be determined by a clutch a segmented impression tray-like device attached to the mandibular teeth with a suitable rigid material such as an impression compound. It is indicated when it is critical to precisely reproduce the exact opening and closing movement of the patient to the articulator, but it had the disadvantage that it is expensive, and requires extensive chair side assistance **(Rathee, Malik and Jyotirmay, 2014).**

1.4. Parts of facebow

1.4.1. U-SHAPED FRAME

It forms the mainframe of the face bow. All other components are attached to this frame. It extends from the region of TMJ on one side to another side without contacting the face **(Deepak Nallaswamy Veeraiyan, 2017).**

Figure (1-2): U-shaped frame **(Deepak Nallaswamy Veeraiyan, 2017).**

1.4.2. CONDYLAR RODS

Two small metallic rods on either side of the free end of the U-shaped frame contact the skin over the TMJ. They are used to locate the hinge axis and then transfer it to the articulator. Some face bows have earpieces that fit into the external auditory meatus instead of condylar rods **(Deepak Nallaswamy Veeraiyan, 2017).**

Figure (1-3): Condylar Rods **(George, 2006).**

1.4.3. BITE FORK

"U" shaped plate, which is attached to the occlusal rims, is used while recording the orientation relation. It is attached to the frame with the help of a rod called the stem. The bite fork should be inserted about 3mm below the occlusal surface within the occlusal rim **(George, 2006).**

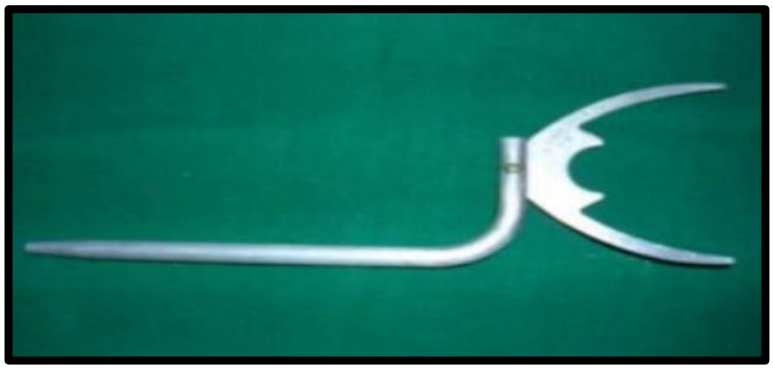

Figure (1-4): Bite Fork **(George, 2006).**

1.4.4. LOCKING DEVICE

This part of the face bow helps to fix the bite fork to the U-shaped frame firmly after recording the orientation relation. This also supports the facebow, occlusal rims, and the casts during articulation. It consists of a transfer rod and a transverse rod. The U-shaped frame is attached to the vertical transfer rod. The position of this transfer rod can be locked with a thumbscrew **(Śarada Guptā, 2009).**

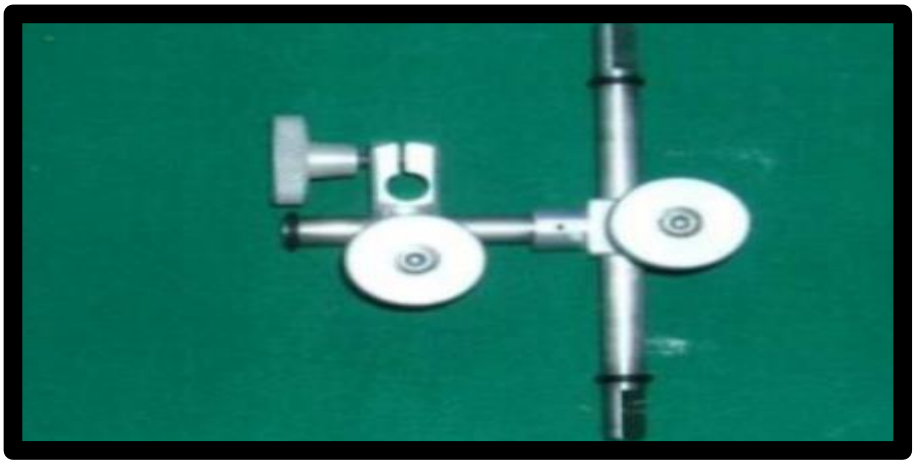

Figure (1-5): Locking device **(Śarada Guptā, 2009).**

The horizontal transverse rod connects the transfer rod with the stem of the bite fork. After positioning the U-shaped frame and the bite fork, the horizontal transverse rod is positioned. It can be positioned automatically by attaching to the transfer rod and the bite fork and tapping it. This type of assembly where the transverse rod gets automatically positioned when tapped is an auto-adjusting or self-centering assembly **(Śarada Guptā, 2009).**

1.4.5. Third reference point marker

It is used to orient the face bow assembly to an anatomical reference point on the face along with the two condylar reference points. It varies in the different face bows, for example, orbital pointer - orbitale, Nose piece Nasion, etc **(Śarada Guptā, 2009).**

Figure (1-6): Third Reference Point Marker **(Śarada Guptā, 2009).**

1.5. Uses of facebow:

- Record the relationship between the condyles and the maxilla/mandible.
- Record the incisal plane angle.
- Determine the correct vertical position on the articulator.
- Record the condylar angle (mandibular facebow).
- Record condylar movements (pantographic facebow). **(Poojya, Aswathy and Shruthi, 2016).**

1.6. Techniques of using facebow:

1.6.1. Denar facebow

The Denar maxillary facebow records the relationship between the maxilla and condyles using an earbow. It also ensures that the incisal plane angle and the vertical height of the models on the articulator are correct. This facebow does not record condylar angle. To use the Denar facebow the following procedure is carried out at the occlusal registration stage once the vertical dimension has been established (here the anterior teeth have been positioned) **(Poojya, Aswathy and Shruthi, 2016).**

- ❖ Attach the bite fork to the occlusal surface of the upper registration rim, ensuring that the bar exit is on the patient's right (Figure 1-7a).

Figure (1-7 A): Attaching the bite fork **(Poojya, Aswathy and Shruthi, 2016).**

- ❖ Mark a reference position on the patient's face to establish the vertical position of the facebow (Figure 1-7b).

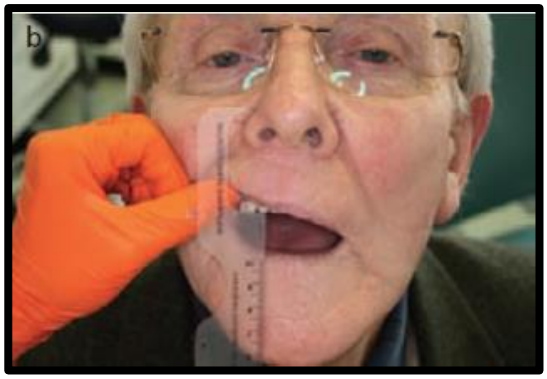

Figure (1-7B): Marking the reference position **(Poojya, Aswathy and Shruthi, 2016).**

- Secure the transfer jig in the earbow with the numbering facing you (Figure 1-7c).

Figure (1-7C): Secure the transfer jig in the earbow **(Poojya, Aswathy and Shruthi, 2016).**

- With the screws loosened to allow free movement, slide the transfer jig onto the bite fork until the earbow is securely seated in the ear (Figure 1-7d).

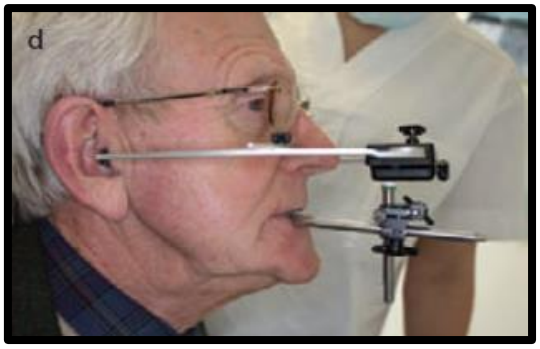

Figure (1-7D): Earbow securely seated in the ear **(Poojya, Aswathy and Shruthi, 2016).**

- Adjust the bow so that the vertical height indicator on the bowlines up with the reference position marked previously.
- Tighten the screws on the transfer jig and check the bow to ensure that the registration rim is seated, the bow is in the ears and the height is correct.
- The RCP record may now be taken and the facebow removed.
- Next, remove the transfer jig from the earbow ready for mounting the models on the articulator. (Figure 1-8) shows the maxillary registration rim held in place on the bite fork with registration silicone.

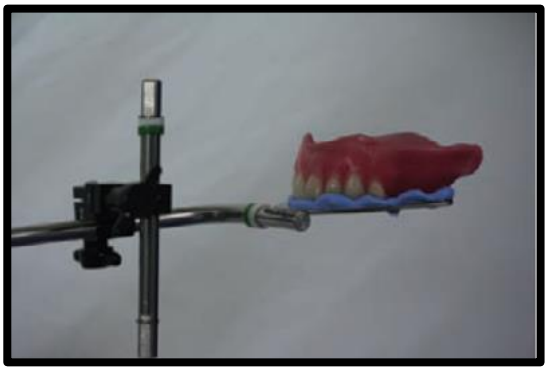

Figure (1-8): Maxillary rim on the bite fork **(Poojya, Aswathy and Shruthi, 2016).**

- Remove the incisal table from the articulator and replace it with the articulating jig (Figure 1-9).

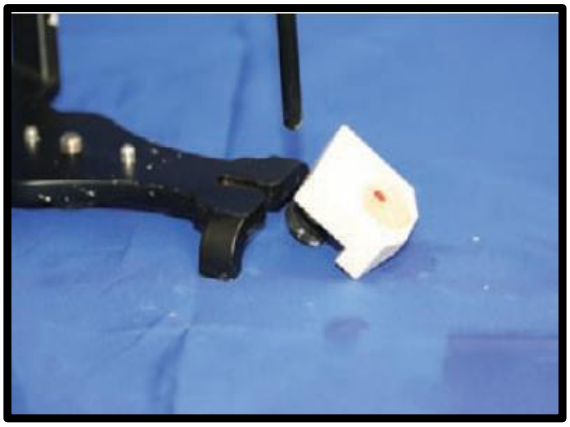

Figure (1-9): Replace the incisal table with articulating jig **(Poojya, Aswathy and Shruthi, 2016).**

❖ Position and secure the transfer jig onto the articulator (Figure 1-10).

Figure (1-10): Positioning the jig on the articulator **(Poojya, Aswathy and Shruthi, 2016).**

❖ The working cast may now be placed in the upper registration rim ready for plastering and secured if necessary (Figure 1-11). Care should be taken to ensure that the weight of the model does not cause movement of the transfer jig. Sometimes the weight of the model can bend the bite fork. If necessary, the device can be attached to the mandibular arm of the articulator and adjusted to support the bite fork and prevent distortion when the model is attached.

Figure (1-11): Cast placed over upper registration rim **(Poojya, Aswathy and Shruthi, 2016).**

❖ Next, mount the maxillary model to the articulator (Figure 1-12).

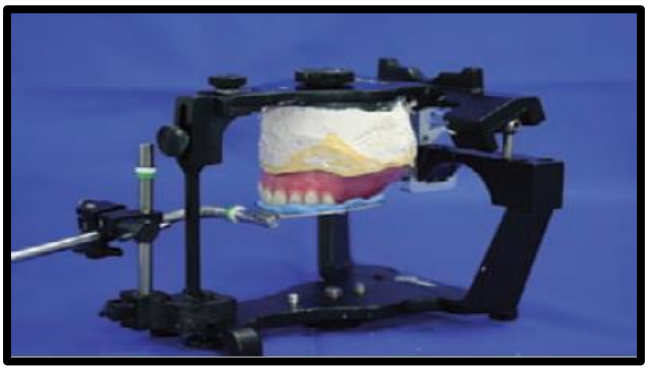

Figure (1-12): Mounting of the model **(Poojya, Aswathy and Shruthi, 2016).**

❖ Then attach the mandibular model using the RCP record (Figure 1-13 A and B).

(Poojya, Aswathy and Shruthi, 2016).

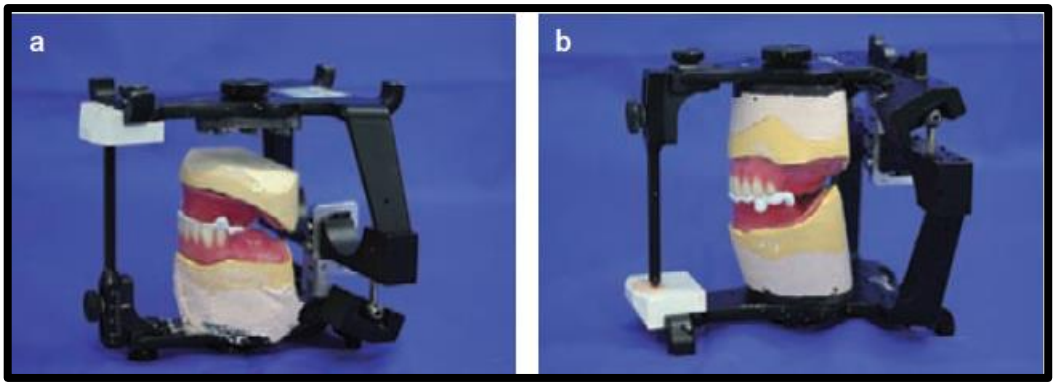

Figure (1-13 A and B) Attaching the mandibular model **(Poojya, Aswathy and Shruthi, 2016).**

1.6.2. Condylar facebow

The Condylator mandibular facebow can be used to establish and record the relationship between the mandible and condyle, and record the condylar angle. It is often used in conjunction with gothic arch tracing to record centric relations. The following procedure is carried out at the occlusal registration stage once the vertical dimension has been established **(Farias-Neto and Carreiro, 2012).**

- Select an appropriately sized biteplate and attach it to the occlusal surface of the lower registration rim, ensuring that the surface is flush with the occlusal plane (Figure 1-14).

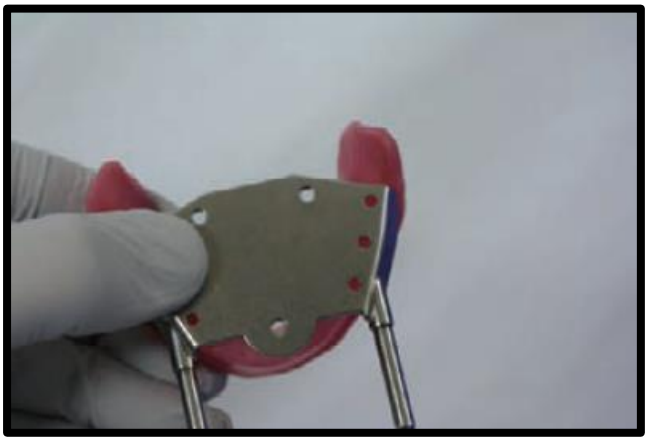

Figure (1-14): Selecting biteplate size **(Farias-Neto and Carreiro, 2012).**

- Mark a reference position over the patient's condyle, either by palpating for the condyle or measuring 13mm anteriorly from the tragus of the ear on a

line between the tragus and the outer canthus of the eye (ala-tragal or Camper's line).

- Position the bow on the biteplate (Figure 1-15). Then place the registration rim into the patient's mouth and adjust the facebow to fit around the face.

Figure (1-15): Position the bow on the biteplate **(Farias-Neto and Carreiro, 2012).**

- With the screws loosened to allow free movement, position and secure the arms of the facebow with the stylus over the condyles (see Figure 1-7c).
- The facebow can now be removed and the centric relation (CR) record taken.
- Next, secure the working model to the lower rim.
- Position the facebow around the articulator such that the sprung writing point holders align with the center of the condyles using the universal adjustment nut on the stand. This replicates the position recorded on the patient (Figure 1-16 A and B).

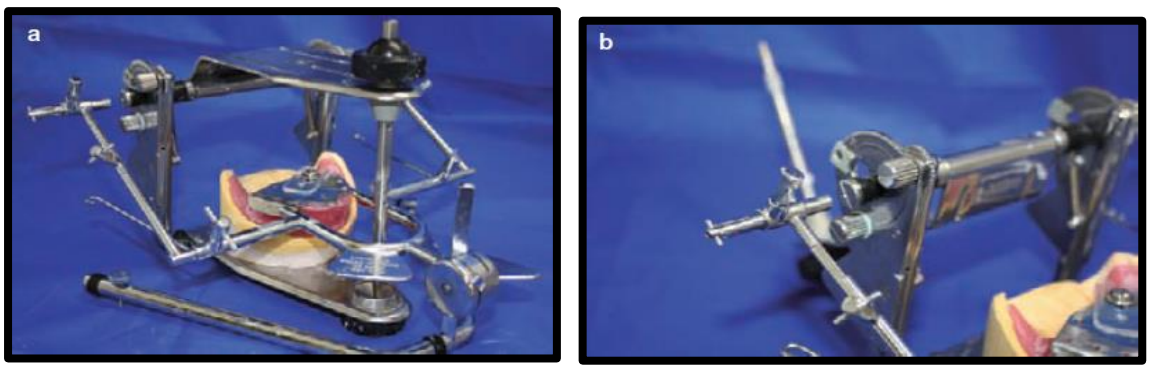

Figure (1-16 A and B): Replicating the position of the patient **(Farias-Neto and Carreiro, 2012).**

❖ Secure the lower model to the articulator and mount the upper using the CR record (Figure 1-17). **(Farias-Neto and Carreiro, 2012).**

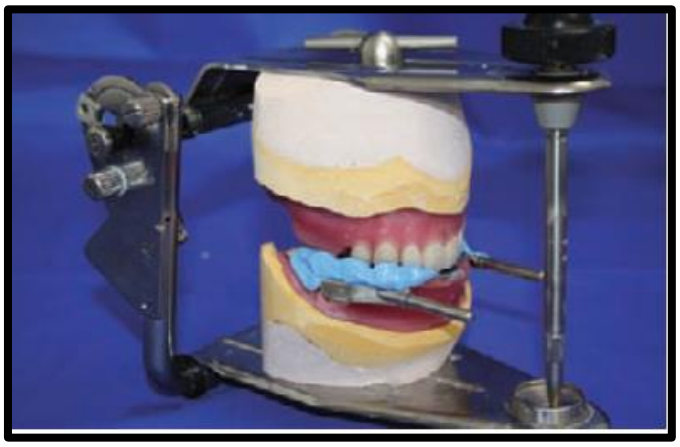

Figure (1-17): CR record **(Farias-Neto and Carreiro, 2012).**

1.6.3. Split cast mounting technique

This technique is a simple method allowing the models to be mounted onto the articulator and then removed and replaced onto the mounting plaster at will. Steep chamfered cuts are made down the side of the models using a model trimmer. The chamfered sections and the bottom of the model are then coated in a plaster separating medium before the mounting plaster is applied. Once the mounting plaster is set and trimmed, the model can be detached from the mounting plaster by sharply tapping the join line between model and plaster. To reattach the model to the mounting plaster the model is accurately positioned into the mounting plaster and model cement (sticky wax) is run along the junction between the two **(Abdelaa, 2017).**

1.6.4. Recording the condylar angle in conjunction with gothic arch tracing using a Gerber facebow:

The GAT devices described here can be used without a facebow. Well-constructed, correctly extended registration rims are essential for stability when carrying out this procedure, which is carried out at the occlusal registration stage once the vertical dimension has been established. During this procedure, the vertical dimension is lost when the GAT is carried out. Therefore, before starting a piece of wire is inserted into the labial surface of each rim and the vertical dimension is recorded using a pair of dividers as shown in (Figure 1-18). The distance between these points is re-established once the stylus and plate have been positioned into the wax rims **(Abdelaa, 2017).**

Figure (1-18): Recording condylar angle **(Abdelaa, 2017).**

1. Mark a reference position over the patient's condyle, either by palpating for the condyle or measuring 13mm anteriorly to the tragus of the ear on a line between the tragus and the outer canthus of the eye.

2. Select a tracing plate and stylus. There are four sizes of tracing plate and two sizes of the stylus to choose from according to the size of the registration rims (see Figure 1-15).

3. Remove 5mm of wax from the maxillary rim (Figure 1-19a).

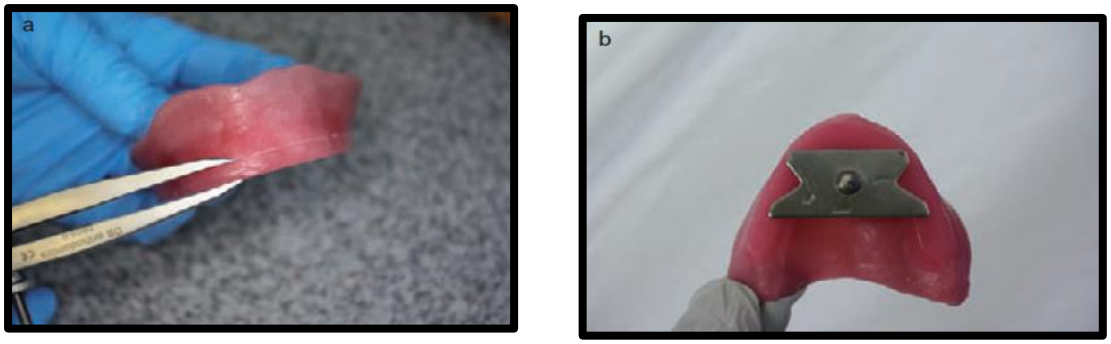

Figure (1-19): A; Removing wax from the rim. B; Seating the stylus over the wax **(Abdelaa, 2017).**

4. Warm the stylus over a Bunsen burner and seat onto the wax rim such that the stylus is over the midline in the premolar region (Figure 1-19b).

5. Choose a lower biteplate to fit the mandibular registration block and secure it using sticky wax (Figure 1-20).

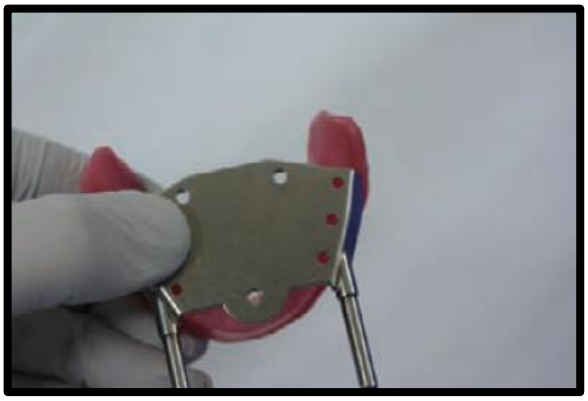

Figure (1-20): Attach the lower biteplate **(Abdelaa, 2017).**

6. Place the registration rims are placed in the mouth and check to ensure that the stylus contacts the lower plate with no other contacts.

7. The face height can now be adjusted using the stylus to the measure previously recorded between the pieces of wire (Figure 1-21).

Figure (1-21): Using the stylus to adjust face height **(Abdelaa, 2017).**

8. Guide the patient through lateral and protrusive excursions. At this stage, there should be no contact between the rims except between the stylus and plate. Ensure that the stylus does not slip behind the plate during protrusion. If contact occurs, the vertical dimension should be increased or the rim adjusted. If the stylus slides off the plate, it should be moved further forward.

9. With the facebow tipped towards the operator, position the bow on the biteplate (Figure 1-22). Ask the patient to close together to prevent tipping of the facebow.

Figure (1-22): Positioning of the facebow **(Abdelaa, 2017).**

10. With the screws loosened to allow free movement, position the arms of the facebow with the stylus over the condyles and secure them. The housing

for the spring-loaded pencil should be approximately 1mm away from the skin (Figure 1-23).

Figure (1-23): Positioning the facebow over the condylar **(Abdelaa, 2017).**

11. Once the patient has practiced protrusive and retrusive movements and can do so on request, place a tracing card between the skin and pencil housing.

12. Orientate the card so that the horizontal lines are parallel to the horizontal occlusal plane indicator arm on the facebow.

13. Hold the card securely from behind the patient to ensure that it remains stable during movement.

14. With the patient in the retruded position, gently release the pencil onto the card and instruct the patient to make protrusive movements of the mandible.

15. Remove the pencil from the card. This procedure is carried out three times on each side to ensure the tracings are consistent.

16. Next, remove the facebow from the registration rims and secure it to its stand using the universal joint. Make sure all joints are securely fastened before storing or using the facebow to mount the models **(Abdelaa, 2017).**

The gothic arch tracing is now carried out to establish centric relations. Wax crayon or 'engineer's blue' is applied to the biteplate and the patient is asked to make left and right lateral and protrusive movements. Repeated movements – forwards and back, left and back, forwards and back, right and back – will need to be carried out to produce a clear tracing **(Abdelaa, 2017).**

Some patients require a little practice to be able to carry out the movements easily, particularly those whose previous dentures were not made to centric relation or have excessive wear, causing forward posturing. For those who find the movements hard to achieve, it can be more productive to ask them to move into as many different positions as possible, a clear tracing will eventually result. The tracing is usually a diamond shape, as shown in (Figure 1-24) **(Abdelaa, 2017).**

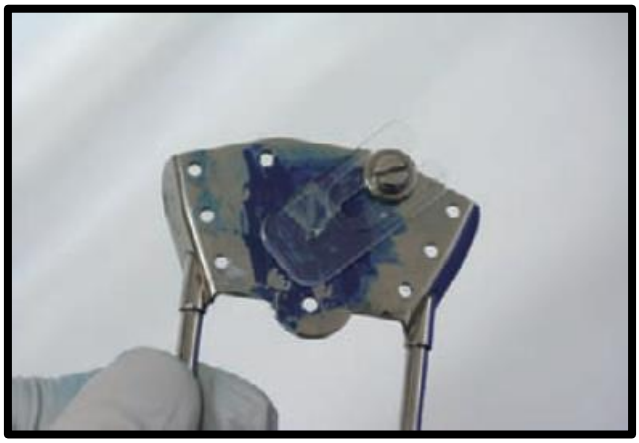

Figure (1-24): Diamond shape tracing (Abdelaa, 2017).

The CR position is the anterior apex. Once tracing has been made, a Perspex disc with a beveled hole is positioned on the lower plate such that the center of the hole is over the apex of the gothic arch tracing. It is fixed in position with sticky wax or model cement **(Abdelaa, 2017).**

The stylus diameter is the same as the diameter of the hole in the disc so the stylus should fit perfectly into the hole if the tracing has been performed correctly (see Figure 1-21). The position is recorded using impression plaster or silicone bite registration material (Figure 1-25) ***(*Abdelaa*, 2017).***

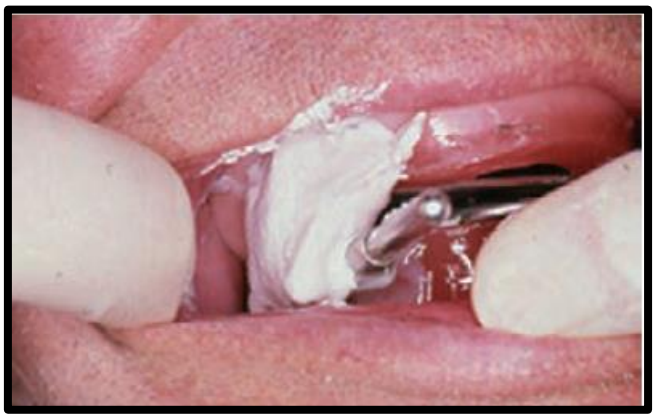

Figure (1-25): Recording the position (Abdelaa, 2017).

1.6.5. Transferring the condylar angle recordings to the articulator

Tangents drawn through the condylar angle tracings can be measured using a protractor, using an average of three tracings per condyle. This angle can then be transferred to the articulator (Figure 1-26 A and B).

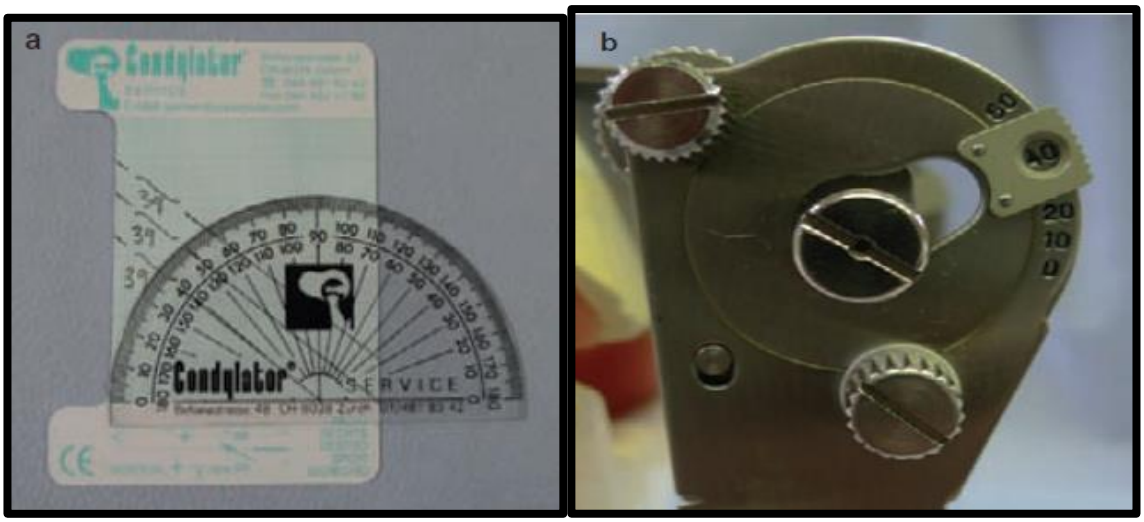

Figure (1-26 A and B): Transferring the angle to the articulator **(Ye and Sun, 2016).**

The facebow is used to mount the lower model on the articulator. The position is adjusted using the universal joint on the stand so that the pencil leads are pointing into the centers of the condyle head of the articulator.

This replicates the relationship of the facebow when it was attached to the patient. The mandibular model is attached to the bite fork using sticky wax and attached to the lower arm of the articulator using plaster of Paris and the maxillary registration rim and model are related to the mandibular model using the plaster or silicone bite registrations (Figure 1-27).

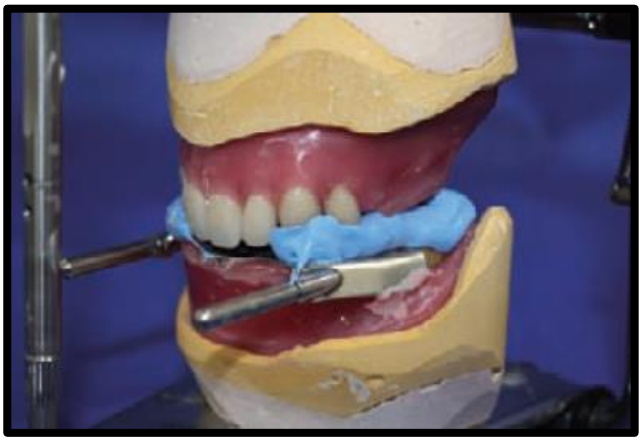

Figure (1-27): Replicating the relationship of facebow to the cast model **(Ye and Sun, 2016).**

Sometimes the procedure can be carried out without having to reduce the maxillary rim by carrying out the recordings at an increased vertical dimension. This means that the condyle path tracings will be inclined 4–6° more horizontally and the vertical dimension of the articulator should be increased before mounting the upper model. This method also affects the condylar inclination recording, so this should be compensated for by adding one-half degree (or 30 angular minutes) to the condyle path angle for each millimeter increase in the vertical dimension measured at the vertical pin of the Condylator articulator **(Ye and Sun, 2016).**

1.7. Is it Necessary to do facebow transfer during the clinical use in prosthodontics?

Recently Kumar and D'Souza did a clinical trial using 20 patients who had normal ridge and class I relation. All of them received two sets of dentures, one set made with face bow transfer and the other without face bow transfer. They found that there was no significant change between both the dentures and the patient was more comfortable with the denture which was made without face bow transfer **(Kumar and D'Souza, 2010).**

In a pilot study done by Turp CJ et al to evaluate whether an arbitrary face bow registration and transfer provide significant advantages in the fabrication of complete denture and occlusal appliances, they could find no clinically relevant benefits with the use of face bow in the fabrication of complete denture a face bow transfer improved the results in terms of patient's speech, the fit and **(Shetty, 2015).**

Keith Yohn got similar results showing no evidence to suggest that using the comfort of the prostheses, ridge morphology, facial contours, the color of the teeth and denture bases, and the psychological aspects of the arrangement of the artificial teeth, chewing efficiency, and stability, of complete denture patients **(Yohn, 2016).**

1.8. Recent advances

The Virtual Facebow has been developed as an advancement of an open-source tablet application that provides an alternative option to the conventional facebow for the mounting of maxillary casts to an articulator. The Virtual Facebow implements several design features that help to minimize errors provide accurate mounting and reinforces the anatomical considerations associated with articulators **(Lepidi et al., 2019).**

The Virtual Facebow is an effective, efficient, and accessible digital companion to dental diagnoses and treatment planning. To support proper mounting of patient casts, a face bow, which aligns the maxilla to relative cranial planes, can be utilized. The virtual facebow was developed to locate the maxillary digital cast of the patient in a cranial coordinate system. The Virtual Facebow has been developed as a digital substitute for the conventional facebow to address its shortcomings **(Lepidi et al., 2019).**

Chapter Two

Conclusion

2. Conclusion

- There is no clinical evidence that can be drawn in favor of the use of Facebow to be essential in the construction of complete dentures, which enhances the denture performance.
- Simpler approaches for the construction of complete dentures may present similar results to more complex techniques.
- The virtual facebow is a recent advancement technique developed to overcome the problem of transferring data from the patient simulation to the virtual articulators.
- The prosthodontist must give good quality dentures to the patients within the available constraints of time and manpower
- So, it is high time to think whether facebow transfer is necessary for complete denture prosthodontics.

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