REVIEW ARTICLE

Posterior Reference Points: A Simplified Classification

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Abstract

Aim: The aim of this review is to summarize the pertinent literature concerning the most appropriate posterior reference point(s) to locate the hinge axis and to arrive at a classification system.

Background: Numerous theories are proposed on the occurrence and the need to trace hinge axis, especially in prosthodontics, to restore lost natural teeth. There is no classification system that exists in relation to posterior reference points.

Review results: Many authors have come up with various theories to locate the arbitrary hinge axis. The perplexing part in remembering these posterior reference points are eliminated by arriving at a classification system.

Conclusion: Depending upon the anatomical landmark and the accuracy to the true hinge axis, a classification was formulated for ease of understanding and learning purpose.

Clinical significance: Achieving a stable restoration requires the transfer of hinge axis as close to the true axis as possible. To enable this, knowledge about the posterior reference points becomes mandatory. Since there are multiple posterior reference points, a classification system would help ease in remembering them.

Keywords: Accuracy, Arbitrary hinge axis, External auditory meatus, Reference points, Tragus.

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Background

Any occlusal rehabilitation warrants the orientation of the maxillae to that of the cranial base to restore proper form and function.[1] The maxilla is spatially positioned by identifying three different points to achieve a plane with the help of a facebow.[2,3] Horizontal reference plane is established by reference points anteriorly and posteriorly, from which posterior occlusal determinants and mandibular movements are established.[4–7] Anteriorly, one reference point is located on the midface and posteriorly, reference points are traced one on either side of the face in the area of the transverse horizontal axis.[8] Hinge axis is an imaginary line connecting the center of rotation on the right and left mandibular condyle.[4,5,9–11]

Clinical Significance

Hinge axis location significance:

- Enables transfer of the opening axis of jaws to that of the articulator, and to simulate the same arc of closure as that of the patients' mouth.[9]
- Used in diagnosis and treatment planning of mounted study models.[4]
- Helps in proper positioning of the casts in relation to intercondylar shaft.[4]
- Hinge axis is the beginning of lateral mandibular movements.
- Alteration in vertical dimension is possible on the articulator.
- To orient the maxilla and to determine the starting point for functional movements of the mandible.[2]
- To check the accuracy of two centric records.[12]

Review Results

Role of Posterior Reference Points

Posterior reference points are important in locating the hinge axis appropriately. The selection of three points in space defines which plane will be termed the reference plane while fabricating a prosthesis.[13,14] Many authors have come up with various reference points, and to simplify the study process we have classified the posterior reference points based on the anatomy and accuracy.[10,15–17]

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Discussion

Shameem, Mahadevan, Manoj and Kamakshi (SMAKs) Classification

Based on Anatomy of the Tragus of the Ear (TE)

Tragus of the ear is a commonly used anatomic reference.[8,10,12,17,18] Table 1 summarizes the posterior reference point based on the anatomy of the tragus.

- Simpson—11 mm anterior to the superior border of the tragus on the camper's line[17] (Fig. 1).

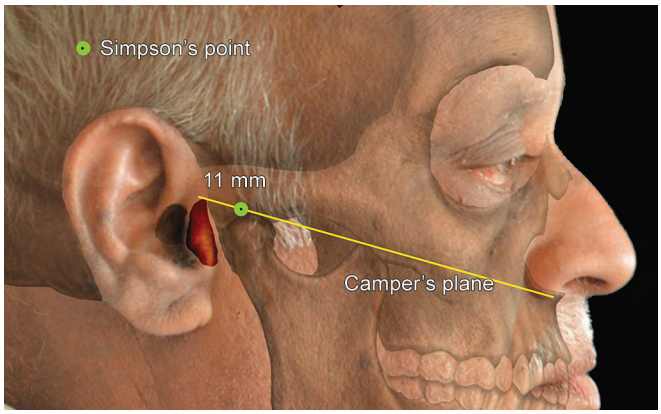

Fig. 1: Simpson's point

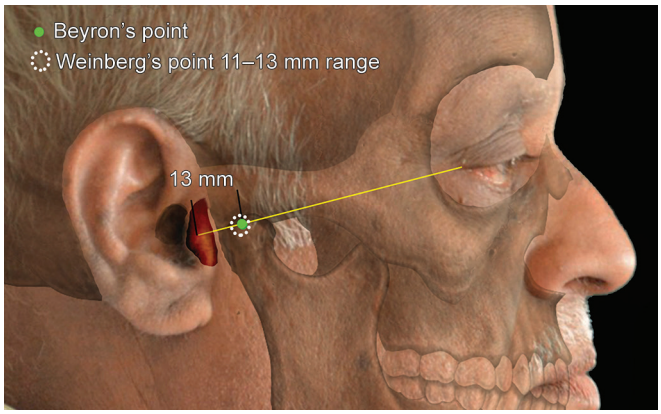

Fig. 2: Beyron's point and Weinberg's point

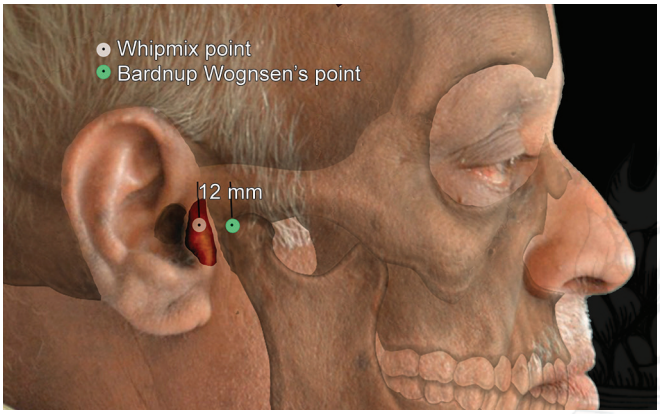

Fig. 3: Whipmix point and Bardnup Wongsen's point

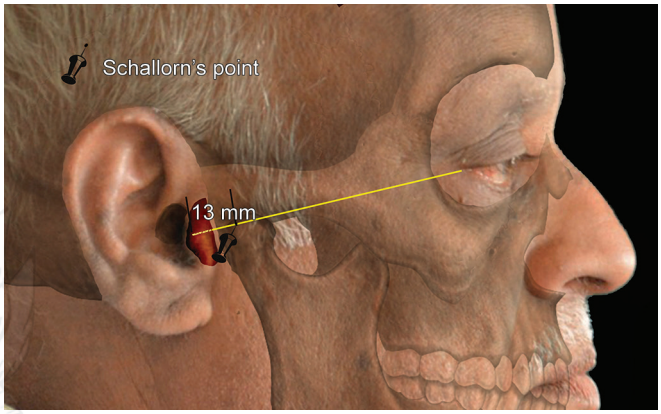

Fig. 4: Schallorn's point

- Beyron—13 mm anterior to posterior margin of tragus on line from the center of tragus to the outer canthus of the eye[8,17] (Fig. 2).
- Weinberg—11–13 mm anterior to the reference line drawn from the middle and posterior border of the tragus[8] (Fig. 2).
- Brandrup-Wognsen—12 mm anterior to most prominent point of posterior border of tragus[16,19] (Fig. 3).
- Schallorn—13 mm from the posterior margin of the tragus to the canthus[17] (Fig. 4).
- Bergstrom—10 mm anterior to the center of spherical insert of the individual's face bow and 7 mm below Frankfort plane[17] (Fig. 5).
- Denar—12 mm anterior to posterior border of the tragus and 5 mm inferior to the line extending from the superior border of the tragus to the outer canthus of the eye[10] (Fig. 6).
- Lundeen—13 mm anterior to the tragus on a line from the base of the tragus to the outer canthus of the eye.[17]

Table 1: Posterior references points with reference to tragus of the ear

Tragal reference	*Author/articulator*
Superior border	Winkler, Swenson
Superior border	Simpson
Center of tragus	Beyron
Middle and posterior border	Weinberg
Posterior margin	Shallhorn and Beck, Brandrup-Wongsen
Posterior and superior border	Bergstorm, Denar
Apex of tragus	McGregor
Base of tragus	Lundeen

Middle of the tragus is almost parallel to the ala tragal line, among the generally suggested ala tragal reference. Of the seven tragal references, ala tragal line was parallel to the occlusal plane in 41.5% situation when superior and middle border of the tragus were chosen. Also inferior border remained to be a poor reference.

Based on the Anatomy of the External Acoustic Meatus (EAM)

External auditory meatus is another anatomic location to trace the hinge axis. Table 2 summarizes the posterior reference points based on EAM.[20]

- Lauritzen and Bodner identified a point 12 mm anterior to the middle of EAM and 2 mm inferior to the porion[16] (Fig. 7).
- Whip mix articulator was in accordance to the design of the ear bow. In the anteroposterior direction at the anterior wall of EAM and in the superior–inferior direction at the level of the most prominent point of posterior border of tragus[21] (Fig. 3).
- Prothero came up with a point on a line from the superior margin of the EAM to outer canthus of the eye intersecting with line 13 mm anterior to the anterior edge of EAM according to Richey's condylar marker[16] (Fig. 7).
- Gysi's point is 13 mm anterior to the anterior margin of EAM on line from superior margin of EAM to outer canthus of eye[17,22] (Fig. 7).

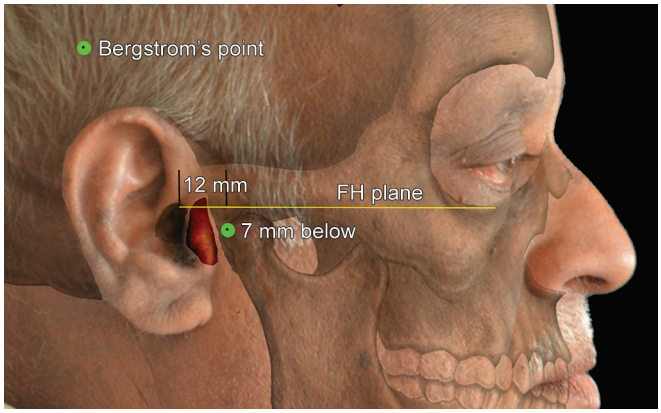

Fig. 5: Bergstorm's point

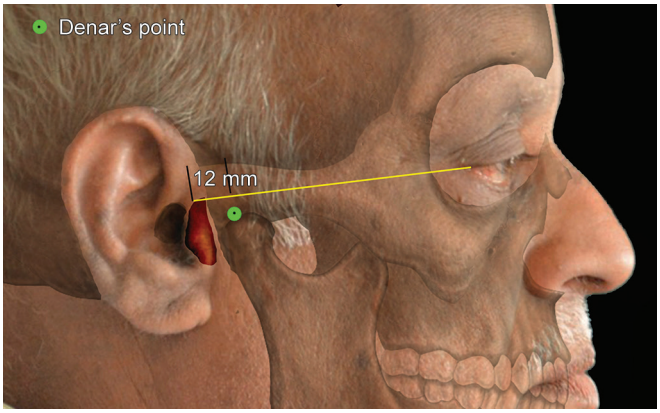

Fig. 6: Denar's point

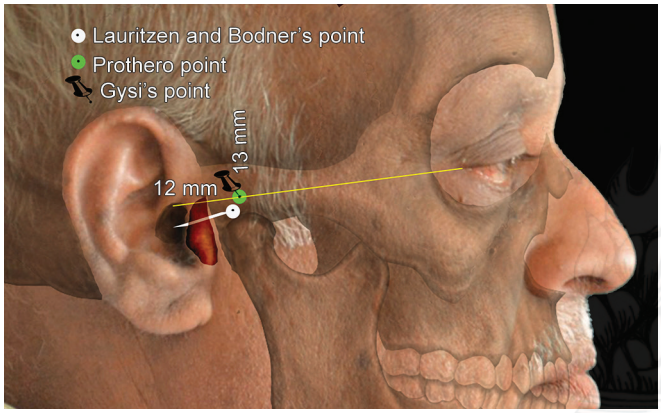

Fig. 7: Lauritzen and Bodner's point, Prothero's pont and Gysi's point

Table 2: Posterior reference point with reference to external acoustic meatus (EAM)

Position of EAM	*Author/articulator*
Center	Lauritzen and Bonder
Anterior wall	Whipmix
Superior margin	Prothero
Anterior margin	Gysi

Based on the Accuracy of Locating within 5 mm Radius

Table 3 summarizes the accuracy of locating the posterior reference points within 5 mm of true hinge axis position.[10,15,17,23]

- Scallhorn—95% of the axis points are located 13 mm anterior to the posterior margin of the tragus on the tragus–canthus line.[15]
- Beyron—approximately 87% and Lauritzen and Bodner—around 33% accurate to the true axis. Teteruck and Lundeen found similar results.[17]
- Walker—20% of the true axis points were located within 5 mm.[10,24]
- Palik, Nelson, and White—92% of the time the arbitrary axis was located anterior to the terminal hinge axis.[23]

Conclusion

Successful prosthetic rehabilitation that involves complex modifications in the occlusion has to be addressed by locating the hinge axis of the patient. This should almost correspond to the opening axis of the articulator. Maxilla is oriented in space using three reference points and thus it becomes essential for one to be aware of the relative significance of posterior reference points for any occlusal rehabilitation. Categorizing the numerous literatures on posterior reference points and simplifying this with the help of a classification system would provide better understanding to the reader. Hence, in this review, classification based on the anatomy and the accuracy has been formulated.

Table 3: Accuracy of posterior reference points within 5 mm radius

Investigator	*Accuracy (%)*
Scallhorn	95
Beyron	87
Lauritzen and Bodner	33
Tetruck and Lundeen	33
Walker	20
Palik, Nelson, and White	50

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