ORTHOCEPH POSITIONER—TO STABILIZE THE FRANKFORT HORIZONTAL PLANE FOR LATERAL CEPHALOMETRY

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ABSTRACT

Introduction:

In orthodontics, the natural head posture is used as a stable, steady, and repeatable external marker, sort of a practical anchor. It becomes pretty important for clinical checkups and also for studies that are meant to be scientific.

Materials and Methods: The idea works because of physics and, more specifically, the hydrostatic notion. This idea says that the surface of a liquid will stay level when you are dealing with a system without acceleration. By default, the liquid surface ends up aligned in a perpendicular way to gravity. In a setup where the fluid is level, the two spots where the fluid touches both the glass and the air will remain at the same elevation. That happens because the gravitational forces are in balance. From that reasoning, a device was constructed, with the goal of capturing a patient's head attitude in its natural orientation before the usual extraoral pictures were taken and before lateral cephalometry.

Conclusion:

Cephalograms using a basic fluid level instrument, paired with a standardized protocol and radiographic review, helped keep everything consistent for capturing and reproducing the natural head position. In other words, it is a pretty straightforward but still very precise way to record head posture and then recreate it during orthodontic treatments, even when things get a bit complicated.

INTRODUCTION

Natural head position (NHP) has become an important reference orientation in orthodontic diagnosis, particularly because it provides a clinically relevant representation of the patient's craniofacial relationships. The introduction of NHP into orthodontic assessment is commonly attributed to Downs in 1956, who emphasized its usefulness in obtaining a more accurate and physiologically meaningful assessment of craniofacial morphology.[1] Unlike arbitrary radiographic reference orientations, NHP reflects the patient's natural head posture and therefore provides an orientation that is closely related to the individual's functional and visual environment. Over the subsequent decades, numerous investigators have examined the reproducibility and reliability of NHP and have proposed different methods for achieving consistent head registration. Techniques such as mirror-gazing, photographic recording, and the use of visual reference points have been employed to minimize variations in head posture during clinical and radiographic procedures.[1]

Historically, the concept of natural head posture can be traced to the work of Von Baer and Wagner in 1861 and subsequently to Broca in 1862. These early observations recognized that humans tend to position the head instinctively in an orientation that allows the visual axis to remain approximately horizontal.[2] This natural orientation is particularly evident when an individual is asked to look toward a distant point situated approximately at eye level. In this position, the head assumes a posture that is comfortable, functional, and relatively reproducible. The concept was subsequently investigated and standardized more systematically by Solow and Tallgren in 1971, who described methods for recording natural head posture and demonstrated its clinical relevance in craniofacial analysis.[2]

NHP differs from conventional cephalometric positioning because it is not primarily dependent on an internal anatomical plane or a fixed skeletal landmark. Instead, it represents an externally determined orientation based on the patient's natural postural response. This characteristic is particularly valuable because craniofacial structures can exhibit considerable individual variation, and internally derived reference planes may not always provide an accurate representation of the patient's actual facial orientation. By maintaining the head in a natural and physiologically balanced position, NHP allows the clinician to evaluate facial proportions, anteroposterior relationships, vertical skeletal relationships, soft-tissue profile, and facial esthetics in an orientation that more closely corresponds to the patient's appearance in everyday life.

The increasing use of NHP in orthodontics has also been supported by studies demonstrating satisfactory reproducibility when standardized recording protocols are followed. Its practical advantages include relative simplicity, ease of clinical application, and the possibility of obtaining consistent records between different observers and at different stages of treatment.[3] The ability to reproduce the patient's head orientation is particularly important in longitudinal orthodontic assessment, where even small changes in head posture can influence angular and linear measurements. Consequently, appropriate standardization of NHP is essential when comparing pretreatment and post-treatment records, evaluating growth-related changes, or assessing treatment-induced alterations in facial morphology.[4]

An important consideration in the clinical application of NHP is the relationship between natural head posture and the conventional cephalometric reference planes. Among these, the Frankfort Horizontal Plane (FHP) has historically occupied a central position in orthodontic and craniofacial analysis. The FHP is conventionally defined by a line connecting the Porion and Orbitale landmarks. For more than a century, this plane has been used as a fundamental reference for orienting the skull and establishing standardized craniofacial measurements. Its widespread use has facilitated communication between clinicians and researchers and has provided a common framework for cephalometric evaluation.

Role of FHP Stabilization in Orthodontics

Maintaining the FHP in true horizontal alignment is critical, since even small deviations can create angular discrepancies, resulting in diagnostic errors and less precise treatment planning. [2]. Traditional cephalostats, which typically use ear rods and nasion rests, often introduce variability due to operator technique, anatomical uniqueness, or patient discomfort. These limitations may alter the natural head posture and shift reference planes. Ensuring consistent and accurate positioning becomes even more important in longitudinal orthodontic studies, where reliable comparisons of pre-treatment and post-treatment radiographs are fundamental for sound clinical decision-making. [4]

Device

A lightweight, translucent orthodontic positioning apparatus fabricated from acrylic sheets integrated with a miniature spirit level (bubble vial) for accurate stabilization of the Frankfort horizontal plane during cephalometric imaging.

In one embodiment, the device attaches externally to the cephalostat framework, providing a direct horizontal reference via the bubble level aligned with the FHP.

In another material, the translucent acrylic sheet permits radiographic X-ray penetration without obstructing or distorting the cephalometric image, while simultaneously serving as a positioning guide.

The OrthoCeph Positioner improves cephalometric accuracy, reduces inter-operator variability, enhances patient comfort, and allows reproducibility in longitudinal orthodontic assessments.

It's also used for stabilizing the NHP in extraoral photographs.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in detail with the following illustrative figures:

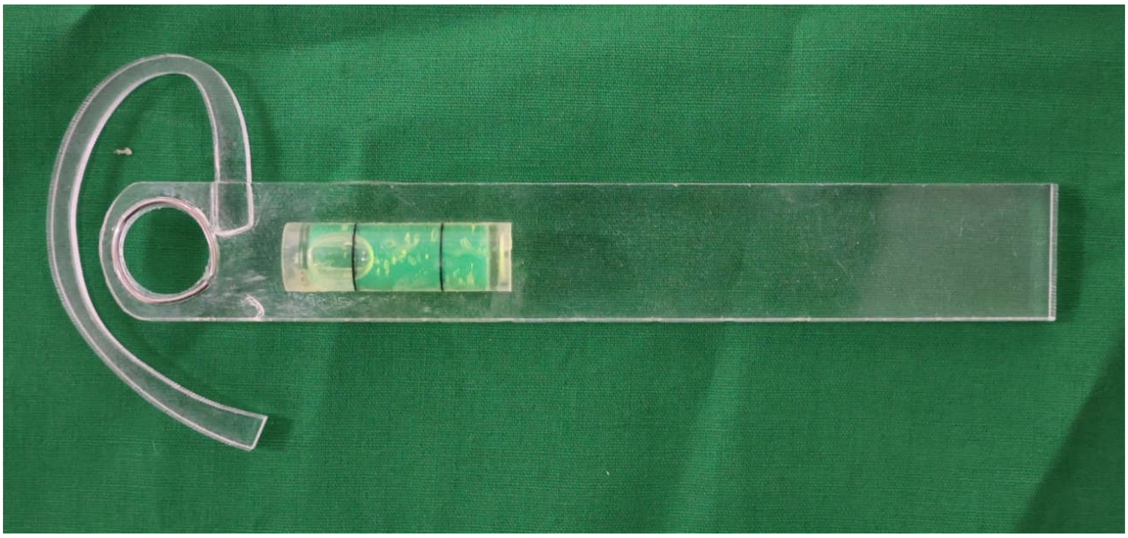

Figure 1: Side view illustrating alignment of device with Frankfort plane.

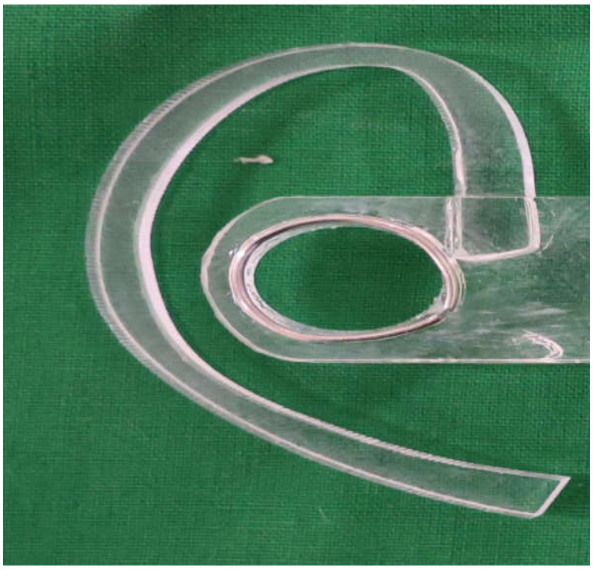

Fig. 2: Stainless steel metal ring

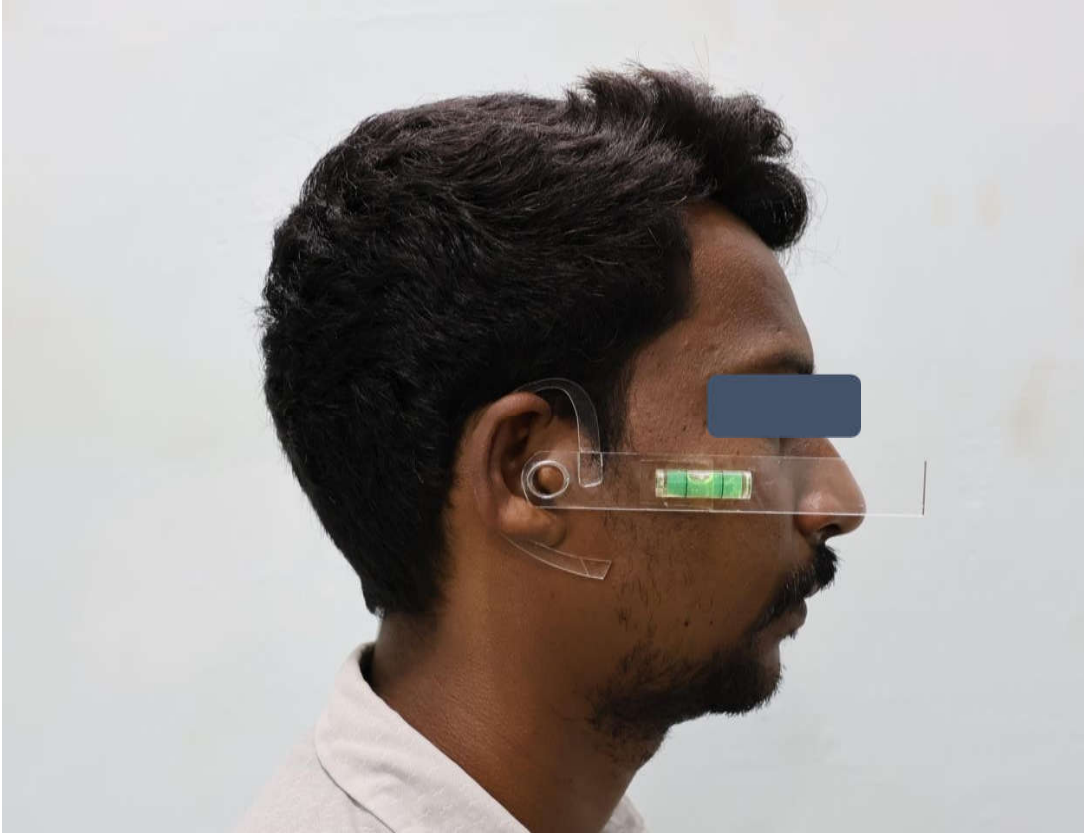

Figure 3: Demonstration of a patient positioned with FHP stabilized using a device for extraoral photographs

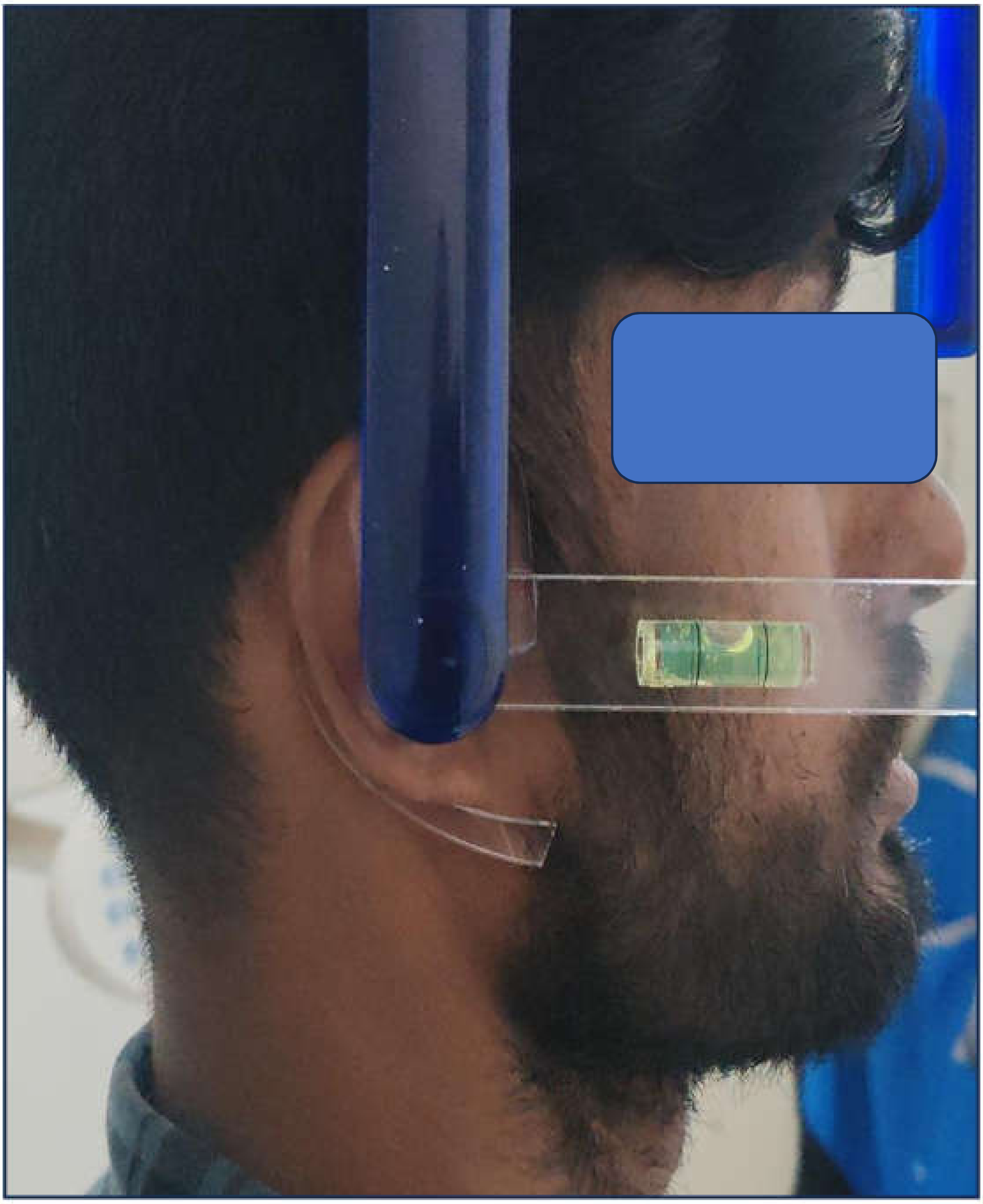

Figure 4: Demonstration of a patient positioned with FHP stabilized using a device for lateral cephalometry

Procedure for using NHP

The following procedures are involved in taking an NHP radiograph: Step 1: An earpiece attachment is used to secure the gadget to the patient's ear. Step 2: Insert the ear rods into the stainless steel ring to orient the portion point in the device. Step 3: The patient is given instructions to stand upright, place his or her arms by their sides, and gaze off into the distance. This step of the process is an attempt to regulate the overall body alignment. Step 4: Adjust the rotation of the fluid level on the pivot until the bubble is in line with the FH plane in the middle of the rod. Step 5: An assessment of NHP's reliability is conducted. The patient is prepared for radiography if close observation demonstrates that head-position recording using this technique consistently brings the bubble back to its center of alignment with the rod.

Advantages of the Natural Head Position (NHP) Device

- The NHP positioning device offers several advantages in achieving standardized and reproducible head orientation during cephalometric and photographic procedures. Its principal benefit is the ability to maintain a consistent orientation of the Frankfort Horizontal Plane (FHP) across repeated records. By providing an objective physical reference for positioning the patient, the device helps reduce variations in head posture that may occur between different imaging sessions. This is particularly important in longitudinal orthodontic investigations, where small changes in head orientation can influence angular and linear measurements and may consequently affect the interpretation of treatment-related changes.
- Another important advantage is the reduction in operator-related variability. Conventional positioning of a patient frequently depends on the clinician's visual judgment and experience, particularly when attempting to establish a consistent relationship between the patient's head and the imaging unit. The NHP device provides an additional standardized reference that assists the operator in reproducing the desired orientation without relying entirely on subjective visual assessment. Consequently, differences associated with individual operator technique can be minimized, thereby improving the consistency of cephalometric records.

- Standardization of head positioning also contributes to improved diagnostic reliability. When radiographs or photographs are obtained with a similar head orientation, anatomical structures can be assessed under comparable conditions. This becomes especially valuable when pretreatment and post-treatment records are compared. Consistent positioning allows observed changes in skeletal, dental, and soft-tissue relationships to be more confidently attributed to growth or orthodontic treatment rather than to differences in patient posture during image acquisition. The device may therefore improve the reliability of longitudinal assessment and facilitate more accurate evaluation of treatment outcomes.
- An additional advantage of the device is its relatively simple and economical construction. The positioning system can be fabricated using inexpensive and readily accessible materials, such as an acrylic framework combined with a conventional spirit vial. This makes the device potentially suitable for routine clinical use as well as research applications, particularly in settings where commercially manufactured head-positioning systems may be expensive or difficult to obtain. The simple construction also permits easy maintenance and replacement of individual components when required.
- The device is designed to be lightweight and convenient to handle, which facilitates its use during repeated clinical examinations. Its reusable nature makes it suitable for multiple patients when appropriate infection-control and disinfection protocols are followed. The design can also be adapted to provide adequate patient comfort while maintaining the required reference orientation. An ergonomic positioning system is important because discomfort or excessive restriction of natural head posture may cause the patient to alter their position during image acquisition, thereby compromising the reproducibility of the record.
- The application of the device is not necessarily limited to cephalometric radiography. The same positioning principle can be extended to standardized clinical photography, where maintaining a reproducible head orientation is equally

important. Standardized frontal and profile photographs are frequently used for evaluating facial symmetry, facial proportions, soft-tissue profile, and treatment-related changes. By helping the patient reproduce a predetermined head orientation, the device may facilitate more consistent photographic documentation during different stages of orthodontic treatment.

- A further feature of the device is the incorporation of a stainless-steel ring that functions as a radiopaque reference marker. During radiographic exposure, the metallic ring becomes visible on the radiograph and can serve as an external positional indicator. This radiopaque marker provides a means of identifying the orientation established by the device on the resulting image and assists in determining whether the intended reference position has been maintained. Such a feature can be particularly useful when the objective is to reproduce a specific orientation during sequential radiographic examinations.
- The radiopaque marker may also facilitate subsequent analysis by providing an identifiable reference corresponding to the physical positioning system. This can assist in evaluating the relationship between the patient's anatomical structures and the intended FHP orientation. In research settings, the presence of a reproducible external marker may further contribute to the standardization of image acquisition and reduce uncertainty associated with subjective assessment of head orientation.
- Overall, the NHP device combines simplicity, affordability, portability, and reproducibility with the potential to reduce operator-dependent errors. By providing a standardized method for orienting the patient's head, it can improve the consistency of cephalometric and photographic records and facilitate more dependable comparison of serial images. Its low-cost construction and reusable design may also make it particularly advantageous for clinical and academic environments where sophisticated commercial positioning systems are not readily available. The incorporation of a radiopaque stainless-steel marker further enhances its utility by providing a visible

reference on radiographs for assessing and documenting the established orientation..

Discussion

Neuromuscular mechanisms that help regulate cranial position are influenced by everyday functions such as breathing and swallowing. Recent research has increasingly examined how external factors might affect cranial posture and how these changes could be associated with certain malocclusions. Solow and Tallgren investigated the potential role of head posture in facial skeletal development, while Solow and Kreiborg put forward the soft tissue stretching theory, suggesting a causal relationship between head position and craniofacial morphology. [5, 6]

Studies by Ferrario et al. reported that the difference between the Frankfort horizontal plane and the true horizontal was about 5° in seated individuals and 13° in standing subjects, implying that people adopt a more upright head position when standing.[7] Similarly, Preston et al. found that most men displayed a slight extension of about 2° in head posture when walking, compared to their average natural head position. These variations raise the clinical question of which position should be regarded as the “ideal” head posture.[8]. Orhan recommended adopting the posture most consistently used by individuals within the natural head position range.[9].

Dynamic variations in head posture have also been observed. Cleall et al., using cinefluorography, noted a brief extension of the head during swallowing, though the method’s high radiation exposure limits its routine clinical use. [10] To overcome this, Murphy et al. developed a dynamic assessment device using an inclinometer. Their system proved effective but was limited to detecting sagittal head tilt, as the attachment to the cranium weighed approximately 110 g. To improve this, a lightweight version was later created, with the cranial section reduced to about 21.6 g, minimizing any potential influence on natural head posture. The design also placed wires and sensors outside the subject's visual field and behind the neck to avoid interference or discomfort. Inclinometers were attached to the arms of spectacles without contacting the temples, further preserving normal posture. [11]

Murphy et al. demonstrated that such devices could capture head position consistently across different occasions. The present system expanded on this by measuring both sagittal and lateral tilts, making it suitable for use in lateral as well as posteroanterior cephalograms. A key advantage is that head posture can be recorded outside the radiography room, avoiding psychological influences from the imaging environment, and then precisely transferred to the cephalostat owing to the high sensitivity of the inclinometer. [12]

The role of the hyoid bone is also important in this context. Serving as the attachment site for the suprahyoid and infrahyoid muscles, it plays a critical role during swallowing. The digastric muscle increases the oropharyngeal anteroposterior dimension, while the stylohyoid and digastric belly help prevent regurgitation. Beyond swallowing, the suprahyoid muscles support cranial balance by stabilizing the mandible against a fixed hyoid platform. Because these muscles connect near the mandibular symphysis, movements of the chin can passively displace surrounding soft tissues and potentially compromise the airway. The stylohyoid ligament and mylohyoid raphe act like stabilizing cords, limiting excessive displacement of the hyoid. [13]

Although cephalometric methods for locating the hyoid have inherent limitations, general trends can be identified: the hyoid moves forward during cranial flexion, backward during extension, and remains relatively stable during mandibular opening. The newly designed device allows clinicians to capture the patient's natural head position reliably before extraoral photography and cephalometric imaging. This is done with minimal modifications to routine cephalometric procedures by attaching the lightweight inclinometer-based unit to the ear via a simple earpiece.[14]

Conclusion

The proposed approach offers a simple, dependable, and reproducible method for establishing and maintaining the natural head position of orthodontic patients during clinical documentation. The incorporation of a fluid-level mechanism provides a convenient visual reference for achieving a consistent orientation of the patient's head. This assists the operator in minimizing variations in head posture that may occur during repeated recordings. Unlike positioning methods that depend predominantly on visual estimation or individual operator experience, the use of a fluid-level reference provides an objective aid for maintaining the desired orientation. At the same time, the uncomplicated nature of the device allows it to be used without complex equipment or extensive technical training.

Maintenance of a consistent natural head position is important because variations in head orientation can influence the appearance and measurement of craniofacial structures. Changes in the inclination of the head may alter the apparent relationship between anatomical landmarks and reference planes, potentially affecting the interpretation of cephalometric measurements. A standardized positioning procedure can therefore improve the reproducibility of orthodontic records and facilitate more meaningful comparisons between records obtained at different stages of treatment. This is particularly relevant when pretreatment and post-treatment images are evaluated, as consistent positioning helps distinguish genuine skeletal, dental, and soft-tissue changes from variations produced by differences in head posture.

The device may also contribute to more comprehensive orthodontic diagnosis and treatment planning. Recording the patient in a natural and physiologically comfortable orientation allows the clinician to assess facial proportions, facial profile, vertical relationships, sagittal characteristics, and soft-tissue balance in a clinically relevant manner. Such information can complement conventional cephalometric analysis and clinical examination, particularly when facial esthetics and soft-tissue relationships are important considerations in treatment planning.

An additional application of the system is the acquisition of standardized extraoral photographs. Consistency in photographic head orientation is essential when documenting facial appearance before, during, and after orthodontic treatment. The device can assist in reproducing a similar head position during successive photographic sessions, thereby improving the comparability of frontal and profile photographs. This can be particularly useful for evaluating facial symmetry, soft-tissue profile changes, facial proportions, growth-related alterations, and overall treatment outcomes.

The combination of a simple fluid-level reference, ease of handling, patient comfort, and repeatability makes this approach potentially useful in both routine orthodontic practice and research. It can facilitate standardized documentation while reducing dependence on subjective positioning by the operator. Overall, the device provides a practical means of improving the consistency of natural head position registration and may enhance the reliability of orthodontic diagnosis, treatment planning, longitudinal assessment, and extraoral photographic documentation

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