International Journal of Dental Sciences & Research
(A Peer- Reviewed Bi-Annual Journal)

PALATOGRAPHY – A WINDOW INTO ORALDYNAMICS & SPEECH ARTICULATION

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Abstract

A palatogram is a diagnostic tool used to visualize the patterns of contact between the tongue and the roof of the mouth (palate) during speech production. It provides a clear and detailed representation of the articulatory movements, essential for understanding speech mechanics. Traditional palatography involves applying a special substance to the palate to capture tongue impressions, while modern methods, such as Electropalatography (EPG), use sensor-equipped palates to record real-time tongue-palate contact. Palatograms are widely used in clinical speech therapy to assess and correct articulation disorders by offering precise feedback on tongue positioning. Furthermore, palatograms can be applied in language acquisition research, forensic linguistics, and speech disorders related to cleft palate or other structural issues. Despite challenges such as invasiveness and interpretation complexity, the growing advancement of palatographic technologies continues to enhance their accuracy and usefulness in both clinical and research settings.

Keywords: Palatogram, tongue, speech, Electropalatography.

INTRODUCTION

Speech production is the complex and synchronized movement of approximately 160 muscles that control the articulators, such as the lips and tongue, to alter the shape of the vocal tract for speech production.1 The tongue plays a crucial role in this process, adjusting its position and shape for vowel pronunciation and serving as the main articulator for consonants. In consonant production, the tongue makes contact with various parts of the teeth, alveolar ridge, and hard palate. Since dentures may replace or cover these structures, it is essential to understand which specific areas of these structures are typically touched by the tongue when pronouncing each consonant. This knowledge is vital for studying speech production, particularly in individuals with dentures or missing teeth, as it may impact their ability to produce certain sounds correctly.2

A palatogram is a graphic representation of the area of the palate contacted by tongue during a specified activity, usually speech-GPT 8.

J. Oakley Coles, in 1871, was the first to use palatograms.3

HISTORY OF PALATOGRAPHY

"Although palatography is often seen as a relatively modern technique in phonetics, its origins can be traced back to the latter part of the nineteenth century. In the final three decades of that century, numerous researchers and scholars published their findings on methods for studying sound articulation, generating significant interest in this area of research. While many scholars simply followed the methods of their predecessors, others made crucial contributions, introducing new insights and techniques. In 1871, J. Oakley Coles, an Englishman, was the first to propose a method for studying the articulation of sounds. Coles applied a mixture of meal, flour, and mucilage to the roof of the mouth..." 4 "Some have recognized the importance of the palatal contour of dentures for improving phonation. As early as 1899, Snow suggested restoring the anterior lingual alveolar area to enhance phonetics, particularly for the pronunciation of sounds like 's' and 'sh'. Prendergast (1935) emphasized that proper thickening of the lingual alveolar area was crucial for correct speech. Sears (1949) proposed creating a palatogram in cases where the median sulcus of the tongue did not align with the midline of the palate. He recommended grooving the palate just above the median sulcus for patients with little or no tongue sulcus and thickening the area for those with a deep tongue sulcus.

Pound (1951) successfully improved phonetics by contouring the entire lingual aspect of the maxillary denture to resemble the normal palate. In 1958, a method for restoring the lingual alveolar area using palatography was published. This method, along with several beneficial refinements, will be presented here."[5]

PRE-REQUISITE FOR MAKING PALATOGRAM6

1. The artificial palate made must be uniformly adapted, no adhesive must be used.
2. Patient who have severe gagging must not be used for making palatograms.
3. The patient has to be trained to open his mouth after uttering the desired word.

4. The tracing material must not be distasteful and its consistency should permit easy application
5. The palate has to be thoroughly dried before the medium is applied and the medium must have a contrasting colour so that it can be easily identified.
6. Talc is considered the best material that can be used for palatogram, although activated charcoal, chocolate powder have also been used.

TYPES OF PALATOGRAPHY

Palatography can be classified into different types based on the techniques and technologies used to record the patterns of tongue-palate contact. The primary types of palatography are:

1. Traditional Palatography7

Traditional palatography is one of the earliest methods used to visualize tonguepalate contact. It involves the application of a substance, typically a powder or paste, to the roof of the mouth. The tongue leaves an imprint on the substance when it makes contact during speech, and this imprint is captured for analysis. The traditional method can be divided into the following subtypes:

The process begins with the subject spraying a black powder onto the upper teeth and the roof of the mouth, covering both the hard and soft palate. The subject then pronounces the word or phrase to be analyzed. Whenever the tongue makes contact with any of the areas covered by the powder, it removes the black powder. These contact points can then be observed and photographed using the appropriate apparatus.

By positioning the mouth over Mirror A, the subject can view Mirror B, which reflects the velum, hard palate, alveolar ridge, and upper teeth, allowing them to observe where articulatory contact occurs. This method is known as Direct Palatography.

Another approach to palatography involves using a custom-made artificial palate, which is dusted with a marking substance before being inserted into the mouth. After the subject pronounces the target word, the palate is removed, and the regions where the marking medium has been wiped off are noted. If a permanent record is needed, the artificial palate can be photographed or drawn to capture the contact areas.

2. Electropalatography (EPG)

"Electropalatography is a technique used to measure tongue-to-palate contact during speech. The subject wears a custom-made artificial palate, which has electrodes embedded in it.These palates are typically created from dental impressions and are constructed from thin, rigid acrylic. They are designed with clips to secure the palate to the subject's teeth.

The palate covers the area from the front incisors to the junction of the hard palate and velum. Wires from each electrode exit the palate in two separate bundles, one on each side of the mouth. The palate is connected to a multiplexer, while an additional electrode, either bodymounted or hand-held, delivers a small current. When the subject's tongue makes contact with the electrodes, it completes the circuit, and the resulting data is displayed on a computer monitor.

Tongue-to-palate contact is monitored in real-time, recorded, and can be analyzed further."[8]

Electropalatography allows for the analysis of contact patterns over time, but it has certain limitations. Specifically, it only records contact at the points where the electrodes are placed, and the artificial palate may interfere with the speaker's comfort. Additionally, the cost of an EPG system is high, making it challenging to conduct studies involving large numbers of participants. In contrast, static palatography captures the entire tongue impression on the palate. Furthermore, because the associated costs are relatively low, it allows for studies with a larger number of speakers."9

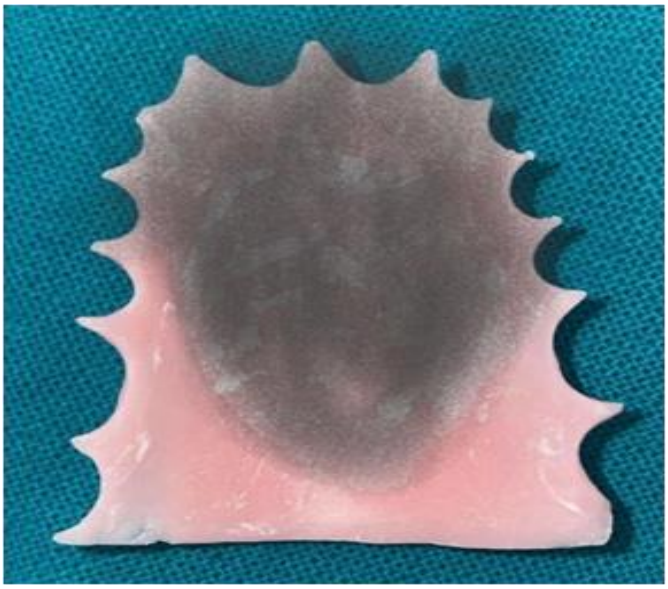
EPG is used to record tongue contact patternsduring speech production, allowing for the creation of a map of these contact points.[10]

PROCEDURE OF RECORDING PALATOGRAM

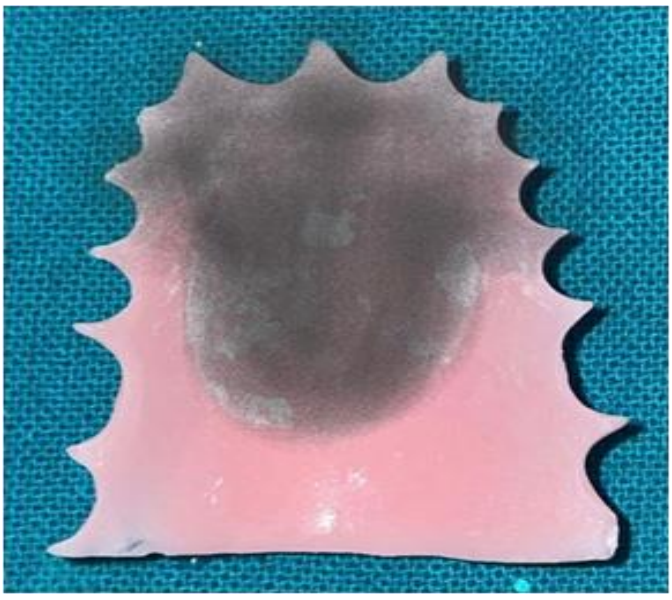
1. Mix charcoal powder and edible cooking oil.
2. Cover the speaker's tongue with the non-toxic paint.
3. Ask the speaker to pronounce the target word once and then to open their mouth and hold their breath.
4. Using an intra-oral mirror take a photograph of the roof of the mouth.

PALATOGRAM OF VOWELS

PALATOGRAM OF SOUND "I"

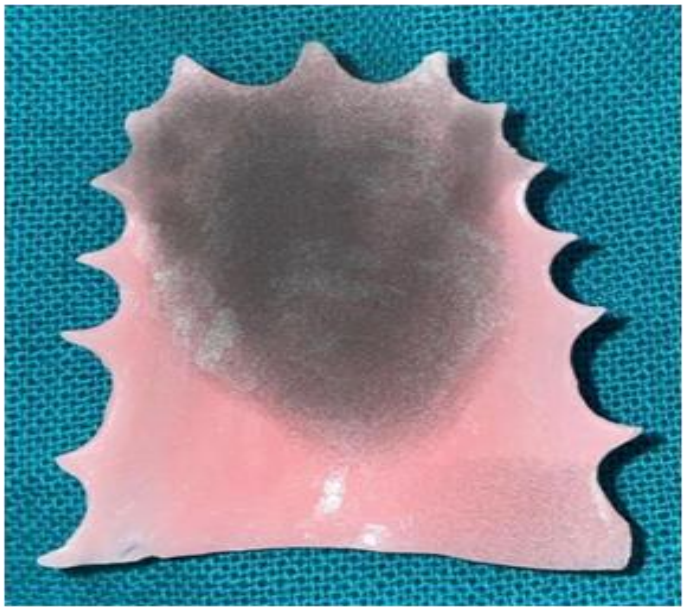


PALATOGRAM OF SOUND "A"



PALATOGRAM OF SOUND "U"

PALATOGRAM OF CONSONANTS



PALATOGRAM OF SOUND "K"

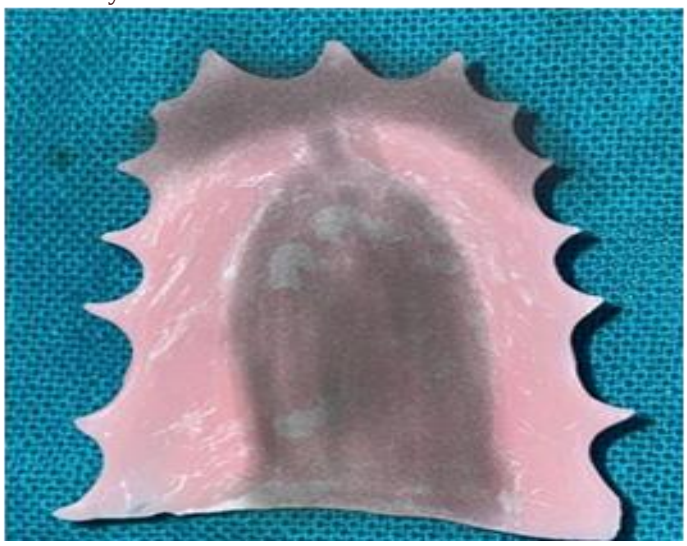
PALATOGRAM OF SOUND "S"

PALATOGRAM OF SOUND "J"

APPLICATIONS OF PALATOGRAPHYIN PROSTHODONTICS-

1. MAXILLARY DENTURE DESIGN[2,11]

During the production of the syllable ‘s,’ the tongue makes contact with the anterior part of the palate, just behind the upper incisors, while the upper and lower teeth come close together without actually making contact. The airstream flows through a median groove formed between the tongue and the hard palate. This groove may or may not align with the median raphe of the palate. To identify this groove, a palatogram can be created using a maxillary trial denture base dusted with talc.

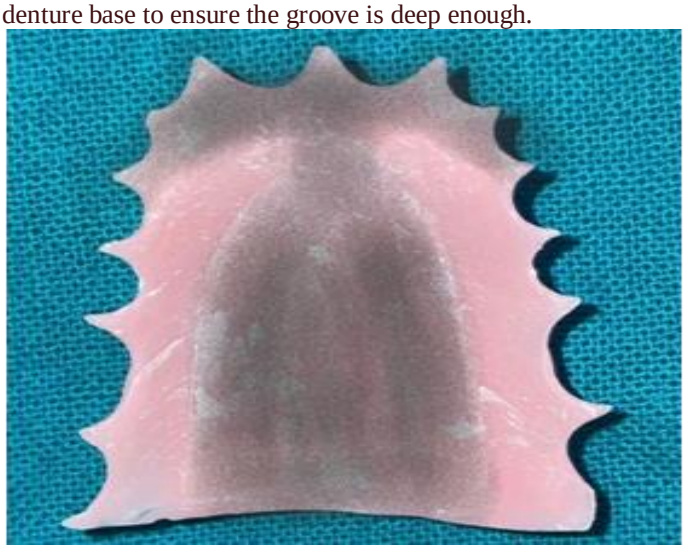


NARROW MEDIAN GRROVE FORMATION ON PRONUNCING SOUND “S”

If the depth of the groove is reduced, the sound of 's' becomes softer, transitioning toward 'sh', and if the groove becomes even shallower, it may produce a lisping sound, resembling 'th'. Excessive thickness of the denture base in the anterior part of the palate is often the cause of a lisp. Conversely, if the groove of the tongue is too deep, the patient may produce a whistling sound while pronouncing 's'.

If a whistling sound occurs when pronouncing 's', it indicates that the tongue's groove is too deep. In this case, the denture base should be thickened in the appropriate area to make the groove shallower.

If a lisping sound is heard when producing 's', the groove is too shallow and needs to be deepened. This can be achieved by identifying the position of the median groove and then trimming the denture base to ensure the groove is deep enough.



An increase in the width of the channel results in a shallower groove in the tongue, leading to the softening of the 's' sound to 'sh' and eventually to 'th'.

2. PALATAL OBTURATORS

Palatal Obturators are often used for patients with maxillary defects (e.g. Cleft palate)

By studying the functional palatogram,the prosthesis can be customised to mimic the natural palatal anatomy, compensating for lost structures.

3. SPEECH AND SWALLOWING DISORDERS

It is used to identify abnormal tongue movements (e.g. tongue thrust) and guide correction through therapy. Palatogram help assess tongue-palate interaction during swallowing, aiding in diagnosis and therapy.

CONCLUSION

In conclusion, palatography stands as a crucial method for understanding the mechanics of speech production, offering a unique insight into the contact patterns between the tongue and the palate. This technique plays an essential role in diagnosing and treating speech disorders, particularly in cases involving articulation difficulties, cleft palates, or neurological impairments. Through both static and dynamic methods, palatography has enhanced our ability to visualize and analyze the subtleties of speech articulation.

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