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Anterior palate, complete denture, modified rugae, palatal contouring, phonetics, speech intelligibility

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The Influence of Anterior Palatal Modifications on Speech Intelligibility in Complete Denture Wearers: A Systematic Review

Abstract

Objectives: To evaluate the influence of anterior palate modifications on speech intelligibility in complete denture wearers.

Methods: This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 guidelines. The Scopus, PubMed, EBSCOhost, and Google Scholar databases were searched for English-language papers published between 2013 and 2025. Search terms were combined using Boolean operators "AND" and "OR." The risk of bias of the included studies was evaluated using the RoB 2.0 tool.

Results: Six studies met the inclusion criteria: one experimental study, three clinical trials, and two in vivo studies. Most employed both subjective and objective measures to assess speech intelligibility in complete denture patients with anterior palate modifications. Quality assessment using the RoB 2.0 tool categorized four studies as "low risk" and two as "some concerns."

Conclusion: The findings suggest that customized rugae, as a modification of the anterior palate, yield better speech outcomes than conventional methods.

Clinical Relevance: Modification of the anterior palate enhanced speech intelligibility in edentulous patients. By restoring palatal contours that aid in the articulation of linguo-palatal sounds like /s/, /t/, and /sh/, patients experience clearer speech and improved communication.

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INTRODUCTION

Speech is a highly coordinated neuromuscular activity involving respiratory support, phonation, articulation, and resonance. The oral cavity plays a critical role in articulation, particularly through the interaction of the tongue with oral structures such as the teeth, alveolar ridge, and hard palate.¹ Complete edentulism can result in persistent speech disorders by disrupting dental articulation zones, significantly compromising speech quality. Specifically, alterations in the anterior maxillary morphology impair the production of distinct speech sounds, particularly affecting the production of sibilant, affricate, and linguo-palatal sounds.²⁻⁴

Complete dentures remain the most common treatment modality for managing complete edentulism. However, their use significantly alters intraoral anatomy and physiology and may even influence cortical brain activity.^{5,6} The anterior palate serves as a critical articulatory contact point for several linguo-palatal and linguo-dental sounds. Modification of this area can therefore have profound implications on speech, especially during the pronunciation of fricatives (/s/, /sh/) and plosives (/t/, /d/) that depend on precise tongue-palate coordination.⁷

Boucher⁸ stated that new dentures could disrupt speech by altering airflow in the mouth, especially when the palate is closed, which affects the pronunciation of certain sounds. Key factors behind these speech issues included changes in vertical dimension, tooth arrangement, the position of the front teeth, tongue habits, and limitations in tongue movement. To help minimize speech problems after fitting complete dentures, adding palatine rugae contours to the palate of the denture base could improve articulation, since a smooth palate could interfere with proper speech.

Phonetic rehabilitation is often cited by patients as a key factor in denture satisfaction and acceptance. Speech disturbances caused by altered palatal contours could lead to psychosocial discomfort, reduced self-confidence, and reluctance to use dentures, especially in social or professional environments. Integrating speech considerations into denture design, particularly through anterior palatal modification, is a clinically relevant and patient-centered approach to prosthodontic rehabilitation.⁹

Despite the clinical relevance of speech intelligibility in complete denture wearers, there is no comprehensive synthesis of evidence examining how anterior palatal modifications influence phonetic outcomes. Existing studies vary considerably in design, methodology, and outcome measures, making it difficult for clinicians to draw clear conclusions. This systematic review addresses this gap by synthesizing the available literature to provide an evidence-based overview of the topic. Thus, this systematic review aims to critically evaluate and

synthesize the existing literature on the influence of anterior palate modifications on speech intelligibility in complete denture wearers.

METHODS

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 guidelines.¹⁰ It was registered with the Prospective International Registration of Systematic Reviews (PROSPERO ID: CRD42024510450).

The focus question for this review was formulated using the PICOS framework:

- Population: Completely edentulous patients receiving complete dentures
- Intervention: Complete dentures with modified anterior palate (rugae incorporation, modified palatal contouring)
- Comparison: Conventional complete dentures without anterior palate modifications
- Outcome: Speech intelligibility
- Study design: Experimental studies, clinical trials, and in vivo studies

The research question was: How do anterior palatal modifications influence speech intelligibility in complete denture wearers?

Inclusion Criteria

Studies were included if they:

- Directly assessed the influence of anterior palatal modifications on speech intelligibility in complete denture wearers
- Were randomized or non-randomized controlled trials, observational studies, prospective studies, cohort and case-control studies, clinical trials, in vivo studies, or cross-sectional studies
- Were published in the English language

Exclusion Criteria

Studies were excluded if they were:

- In vitro studies
- Case reports
- Retrospective studies
- Published in a language other than English

Search Strategy

A comprehensive search was conducted across the Scopus, Medline (PubMed), EBSCOhost, and Google Scholar databases. Search terms were formulated using Medical Subject Headings (MeSH) and combined using Boolean operators "AND" and "OR" to retrieve relevant studies published from January 2013 to September 2025. The detailed search strategy for each database is described in Table 1.

Table 1: Detailed search strategy

Database	Search strategy	Articles considered
PubMed	“anterior palate modification” AND “complete denture” AND “speech intelligibility”	3
Scopus	“anterior palate” AND “complete denture” AND “customized rugae” OR “modified rugae” AND “palatal contour”	82
EbscoHost	“Anterior palate” AND “modified rugae” AND “palatal contour” AND “complete denture”	17
Google Scholar	“anterior palate modification” AND “complete denture” AND “speech intelligibility”	679

Study Selection and Data Extraction

Two investigators independently searched the databases. Any discrepancies and disagreements during the study selection process were resolved through discussion among the authors. Data extraction was conducted using a standardized form and presented in a structured format.

Risk of Bias Assessment

The quality of the included studies was assessed using the RoB 2.0 tool¹¹ by three investigators who independently scored the articles. Disagreements were resolved through discussion. The assessment is presented in Table 2 based on three categories: "High," "Some concerns," and "Low," according to five domains.

Table 2: Risk of bias using RoB 2.0 tool

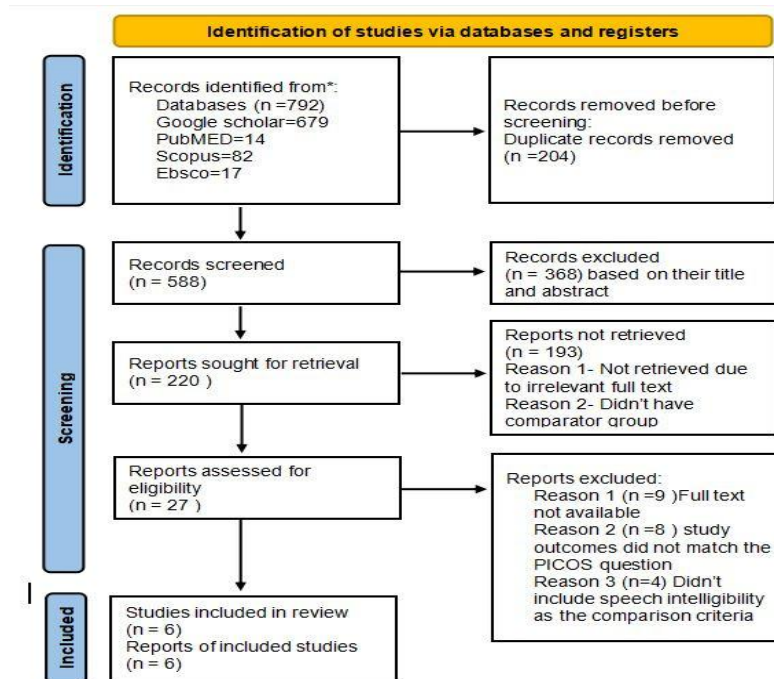
Study article	D1	D2	D3	D4	D5	Overall bias
Niyogi S et.al ¹⁴	High	Low	Low	High	High	Some concerns
Mahross H Z et.al ¹⁵	Some concerns	Low	Low	High	Low	Low
Chaturvedi S et.al ¹⁶	Some concerns	Low	Low	High	Low	Low
Habar I D et.al ¹³	Some concerns	Low	Low	Some concerns	Low	Low
Adaki R et.al ²	High	Low	Low	Some concerns	Low	Low
Bali S K et al ¹⁷	Some concerns	Low	Low	Some concerns	High	Some concerns

RESULTS

A total of 792 articles were initially identified: 82 from Scopus, 14 from PubMed, 17 from EBSCOhost, and 679 from Google Scholar. After removing 204 duplicate records, 588 articles were screened. During the screening phase, 368 records were excluded based on their titles and abstracts. The remaining 220 articles were assessed for retrieval. Of these, 193 articles were not retrieved due to irrelevance or missing key elements such as a comparator group. The remaining 27 articles were assessed for eligibility:

- 9 articles were excluded because the full text was not available
- 8 articles were excluded because the study outcomes did not match the PICOS question
- 4 articles were excluded because they did not include speech intelligibility as the comparison criterion

Ultimately, six articles were included in this systematic review. The study selection process is detailed in the PRISMA 2020 flowchart as shown in Figure 1.

Figure 1: PRISMA Flowchart

Of the six included studies, one was an experimental design study, three were clinical trials, and two were in vivo studies. The majority employed both subjective and objective methods to assess speech intelligibility in complete denture patients following anterior palate modification. The characteristics of the included studies are summarized in Table 3. Quality assessment using the RoB 2.0 tool showed that four articles were in the "low risk" category, whereas two articles were in the "some concerns" category (Table 2).

Table 3: Characteristics of the studies included in the review

Author & year	Type of study	Modification	Outcome	Conclusion	P
Niyogi S et.al, ¹⁴ 2021	Experimental study design	The palatal surface was modified by fabricating complete dentures with customized rugae and customized metallic base.	It was seen that articulation and pronunciation is better with customized rugae dentures with a significant difference.	It was concluded that dentures should be customized either at rugae area or the anterior portion of palate or both, to enhance better tactile location of the tongue for speech enhancement.	P<0.0001
Mahross HZ et.al, ¹⁵ 2015	Clinical trial	They modified the palatal area with rugae fabrication on conventional acrylic resin in thickness of 2-2.5 mm and also constructed palatal rugae with thickness of 1.5-2mm which is less than conventional denture	It was noted that reproduction of rugae in acrylic denture produced highly significant difference.	It is recommended to reproduce the rugae area in complete denture, because the phonetic quality of complete denture with rugae is superior to the conventional denture.	P<0.05
Chaturvedi S et.al, ¹⁶ 2018	In vivo study	The palate of one of the groups was modified with functional	It was seen that both the modifications showed an	It was concluded that speech intelligibility after denture insertion	P<0.05

		contouring and in another group they made a small opening on the anterior part of the palatal base.	increase in speech intelligibility but it was seen that a small opening in the anterior part had better outcomes in production of sounds with high frequency and intensity.	was found to be better in modified dentures (Modification type I and II).	
Habar ID et.al, ¹³ 2020	Clinical trial	In this study they modified the palate with duplicating palatine rugae	The outcome was that a significant difference in speech quality produced on /d/, /t/ was seen in denture wearers with presence of palatine palate.	This study concluded that denture wearers' speech quality with duplication of palatine rugae was better than the one without palatine rugae. The presence of duplicate palatine rugae on a full maxillary denture base can improve speech function in edentulous patients.	P<0.05
Adaki R et.al, ² 2013	Clinical trial	They modified the dentures with both arbitrary rugae and customized rugae in complete dentures.	It was noted that the pronunciation of sounds /d/, /t/ were better with customized rugae dentures.	This study evaluated the impact of palatal rugae on speech using acoustic and intelligibility analyses. Results showed that dentures with rugae, especially customized ones, improved the clarity of sounds like 's' 'sh', 't', 'd'.	P<0.05
Bali SK et al, ¹⁷ 2022	In vivo study	The modification was done by fabricating the anatomic palate in PMMA and also by fabricating the anatomic palate in silicone.	It was seen that the pitch and intensity increased for dentures where fabrication of palate was done using silicone.	It was concluded that speech intelligibility as well as compliance after denture insertion was more in Phase IV (complete denture had anatomic palate fabricated in silicone) followed by Phase III (complete denture had anatomic palate fabricated in PMMA) and Phase II (conventional complete denture).	P<0.05

Across the reviewed literature, modifications such as customized rugae, different thicknesses of rugae, openings on the anterior part of the palatal base, and arbitrary rugae consistently showed positive effects on speech clarity, especially for linguo-palatal sounds such as /s/, /sh/, /t/, and /d/. Several studies reported statistically significant improvements in intelligibility scores and acoustic precision after modification compared with conventional flat palatal designs.

Patients reported enhanced comfort and improved speech confidence after denture insertion with modified anterior palatal contours. Among various techniques, customized rugae patterns were found to be more effective than arbitrary modifications in restoring natural phonetic guidance.

DISCUSSION

This systematic review analyzed the influence of anterior palatal modifications on speech intelligibility in complete denture wearers. The primary objective was to evaluate how these changes affect speech clarity, compare the effectiveness of different techniques, examine the methodologies used for assessing speech outcomes, and identify research gaps.

The findings indicated that incorporating customized rugae during complete denture fabrication yields substantial benefits for speech intelligibility among edentulous individuals. Ando T et al.¹² highlighted that incorporating rugae enhances lingual tactile feedback, replicating the natural palatal anatomy, which could lead to improved speech articulation and swallowing. Their study demonstrated that the depth of palatal contours significantly affects the clarity of specific sounds; a 0 mm curvature optimized the pronunciation of the /j/ sound, whereas deeper contours (6 mm) improved articulation of sounds like [tʃ] and [dʒ] ($P < 0.01$).

Similarly, Habar ID et al.¹³ reported that duplicated rugae improved tactile proprioception, thereby enhancing speech functionality, with statistically significant improvement ($P < 0.05$) in the articulation of /d/ and /t/ sounds. Niyogi S et al.¹⁴ observed that customized rugae dentures resulted in significantly better articulation and pronunciation compared to conventional dentures ($P < 0.0001$). Mahross HZ et al.¹⁵ demonstrated that dentures with rugae improved phonetic outcomes, particularly for sounds such as /sh/, /d/, /z/, /t/, and /l/, noting that excessive anterior palatal thickness distorted these sounds, whereas resilient acrylic rugae significantly enhanced speech ($P < 0.05$).

Chaturvedi S et al.¹⁶ reported that minor anterior palatal openings facilitated the production of high-frequency sounds, yielding significant improvements in speech intelligibility ($P < 0.05$). Bali SK et al.¹⁷ found significant improvement ($P < 0.05$) in speech intelligibility when anatomic rugae were incorporated using extraoral silicone. Adaki S et al.² observed significant enhancement in the pronunciation of /d/ and /t/ sounds with customized rugae dentures ($P < 0.05$).

However, Kar S et al.¹⁸ raised concerns about denture hygiene and maintenance, noting that textured rugae surfaces pose challenges for cleaning. Budtz-Jørgensen E¹⁹ further corroborated this, explaining that plaque accumulation is more prevalent on rough surfaces, which

can lead to calculus formation and complicate denture hygiene, particularly among elderly patients.

Tanaka H²⁰ highlighted that phonetic challenges might arise, especially during the initial adaptation period. Patients may struggle with articulating sounds like 's,' 'sh,' 't,' and 'd' due to difficulty in neuromuscular adaptation to the altered palatal contours, leading to temporary speech distortions.

Contrasting results were reported by Abu-Awwad M et al.²¹ who noted that while palatal rugae were added, patients did not report noticeable improvements in overall satisfaction or oral health-related quality of life.

Based on predominantly low-risk-of-bias studies, customized rugae received a strong recommendation for improving sibilant and plosive sound clarity (/s/, /sh/, /t/, /d/) and enhancing patient comfort and confidence. Anterior palatal openings and duplicated rugae had moderate evidence for selective phonetic improvements but required careful case selection, while arbitrary rugae showed weaker, inconsistent benefits. Flat palatal designs were not recommended due to consistently inferior speech intelligibility outcomes.

Despite these advancements, a consistent limitation across the reviewed studies was the lack of routine inclusion of palatal rugae in conventional complete denture designs. Multiple factors influence speech with dentures, including tooth positioning, flange thickness, and posterior palatal seal integrity. Additionally, denture retention remained a critical determinant of speech quality. A significant limitation is the exclusion of studies published in languages other than English. Future iterations should include studies in other languages to capture a more global perspective. A meta-analysis could not be performed due to the limited number of included studies, heterogeneity in study designs, variations in palatal modification techniques, and differences in outcome measures used to assess speech intelligibility. Inconsistent data reporting and variable methodological quality further restricted quantitative synthesis. An often-overlooked aspect is the patient's emotional and psychological response to prosthetic rehabilitation, which could significantly influence speech adaptation.

Future research should prioritize robust, well-designed randomized controlled trials with adequately powered sample sizes. The adoption of standardized speech evaluation protocols, both subjective and objective, will enhance comparability across studies. Long-term follow-up assessments are essential to evaluate the sustained impact of anterior palatal modifications on speech intelligibility. Future studies should leverage artificial intelligence and machine learning models to analyze speech patterns, providing more objective and reproducible evaluation methods.

CONCLUSION

Phonetics is a critical consideration in the construction of complete dentures. However, it is often overlooked because many patients have adaptive capacity and can achieve acceptable speech despite sub-optimal prostheses. Completely edentulous individuals using dental prostheses tend to mispronounce certain sounds, the pronunciation of which depends upon the rugae pattern and palatal contour.

Within the limitations of this systematic review, the following conclusions can be drawn:

1. Anterior palatal modifications improve speech intelligibility in completely edentulous patients.
2. Among the various modification techniques, customized palatal contours were found to be superior.
3. Both patient-reported outcomes and acoustic evaluations consistently indicated improved speech clarity and greater patient satisfaction with anterior palatal modifications compared to conventional complete dentures.
4. Standardized protocols for speech assessment in complete denture wearers are needed to facilitate future research and clinical application.

List of Abbreviations:

Abbreviation	Definition
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROSPERO	Prospective International Registration of Systematic Reviews
MESH	Medical Subject Headings
PICOS	Population, Intervention, Comparison, Outcomes and Study design

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