Open Access Library Journal
2025, Volume 12, e13428
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Prosthetic Rehabilitation of Completely Edentulous Complex Cases: The Role of Piezography

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How to cite this paper: Elabdouli, R., El Assraoui, K., Rimaoui, S. and Bellemkhannate, S. (2025) Prosthetic Rehabilitation of Completely Edentulous Complex Cases: The Role of Piezography. *Open Access Library Journal*, **12**: e13428.
https://doi.org/10.4236/oalib.1113428

Received: April 14, 2025
Accepted: June 27, 2025
Published: June 30, 2025

Abstract

Prosthetic rehabilitation of mandibular edentulism represents a major challenge for dentists, particularly when dealing with patients with advanced resorption of the alveolar ridge or tissue loss due to surgical interventions. These complex clinical situations frequently compromise the effectiveness of conventional prosthetic solutions, leading to limitations in stability, retention, and patient comfort. Piezography plays a crucial role in managing clinical cases with severely resorbed or atypical ridges through the design of customized, comfortable prostheses. In addition, phonetic piezography improves patients' quality of life by restoring efficient masticatory function and clear phonation. This article explores the technique of phonetic piezography, a method based on recording tissues in motion during phonation. The patient is asked to repeat phonemes such as "sis", "so", "te", "de", "me", and "pe". Each phoneme is carefully articulated to record a specific area. Through the analysis of two clinical cases, this technique has demonstrated its effectiveness in creating precisely adapted mandibular prostheses, even in very difficult anatomical conditions. By precisely registering the areas of contact between the prosthesis and the tongue, cheeks and lip, this technique improves prosthesis stability, reduces mucosal irritation and ensures harmonious integration with the patient's natural movements.

Subject Areas

Dentistry

Keywords

Resorbed Ridge, Phonetic Piezography, Neutral Zone

1. Introduction

The prosthetic rehabilitation of a completely edentulous mandibular arch represents a major challenge for dentists, due to the anatomical and functional alterations associated with tooth loss, bone resorption and aging phenomena. Among the most complex cases are severely resorbed mandibular arches, associated with bone loss following tumor resection surgery.

Implant-supported overdentures are an effective solution to the issue of prosthetic instability in cases of severely resorbed ridges. However, piezography is an alternative when implant placement is not possible, due to the patient's general health condition or financial constraints.

The piezographic impression technique, a method that records the dynamic and functional margins of the prosthesis, is particularly useful for optimizing prosthetic integration in these clinical cases [1]. It enables precise adaptation of the prosthesis to the residual structures, taking into account muscle movements and the limited bearing surface [2] [3].

The neutral zone is the region in the oral cavity where the inward forces from the lips and cheeks balance the outward pressures exerted by the tongue during functional movements.

Piezography can be performed using either swallowing or phonation; however, phonation remains the method of choice according to many authors for several reasons. Unlike swallowing, which has limited utility when phonetic considerations are excluded, phonation is the function most likely to displace the prosthesis from its mucosal support due to the amplitude and intensity of the paraprosthetic tissue movements it generates. Additionally, phonation produces active horizontal forces on the prosthesis, whereas mastication and swallowing primarily involve stabilizing occlusal contacts. Furthermore, phonation is less affected by tooth loss compared to other oral functions, making it more reliable for prosthetic evaluation [4] [5].

This article presents the application of phonetic piezography in two distinct clinical scenarios. The first case demonstrates its use in the prosthetic rehabilitation of a severely resorbed mandibular arch, while the second illustrates its application in a patient with post-resection bone loss following mandibular tumor surgery. This technique offers specific solutions to the challenges faced in managing these cases.

This method plays a critical role in designing customized, comfortable prostheses, offering a valuable solution for patients with severely resorbed or anatomically atypical ridges. Furthermore, phonetic piezography significantly improves patients' quality of life by restoring functional mastication, clear speech, and enhanced aesthetics.

2. Clinical Case 1

An 84-year-old edentulous female patient in good systemic health presented to the Department of Removable Prosthodontics at Hassan II University's Faculty of

Dental Medicine, Casablanca, Requesting new dentures. Her chief complaint was severe mandibular denture instability while wearing an old complete bimaxillary prosthesis.

Extraoral examination demonstrated reduced lower facial height with concomitant mandibular prognathism. Clinical and radiographic assessment revealed a concave (negative) mandibular ridge, severely compromising prosthetic stability and retention. This presentation aligns with Sangiuolo Class IV, a condition associated with a highly unfavorable prognosis for conventional mandibular prosthetic rehabilitation (**Figure 1** and **Figure 2**).

Given the inherent challenges of flat or concave (negative) mandibular ridges, conventional prosthetic techniques frequently yield suboptimal outcomes. Phonetic piezography emerges as a clinically valuable alternative, allowing for precise recording of the dynamic prosthetic space boundaries. This method delivers critical biomechanical guidance to optimize prosthesis design and adaptation, thereby enhancing stability and patient tolerance.

Figure 1. Endobuccal view revealing a highly resorbed mandibular ridge.

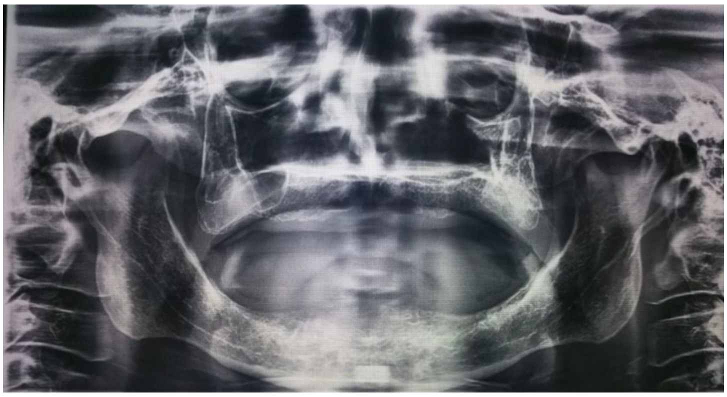

Figure 2. Panoramic radiography.

A primary mucostatic impression is obtained using plaster in a stock impression tray (**Figure 3**). From this impression, a 2 mm thick rigid self-curing resin base is fabricated. This customized base serves as a foundation for subsequent impression materials while providing structural support during functional assessments

(Figure 4).

The base requires intraoral adjustment through standardized phonetic tests (Herbst and Devin tests), ensuring stable retention during speech without displacement. Light-body silicone was then applied to the intaglio surface and borders of the custom tray to identify and relieve areas of excessive tissue pressure.

Figure 3. Primary plaster impression.

Figure 4. Rigid resin base.

The ideal material for piezographic recording must satisfy two essential criteria: dimensional stability and accuracy. Furthermore, it should demonstrate adequate working time to permit clinical manipulations [6]. While both tissue conditioner materials and polysulfide impression materials meet these requirements, we selected a high-flow polysulfide impression material (Permlastic Regular®) for this procedure.

The neutral zone recording protocol comprises four sequential steps:

First Step: Buccinator Modeling (Figure 5):

The patient is seated with her head stabilized in a natural position, simulating an informal conversation. She is instructed to repeat the French phonemes "SIS" six times followed by "SO" once. A custom tray impression, loaded with material on the right side at the extrados, is inserted, and the patient continues repeating the phonemes until the material achieves sufficient rigidity to resist deformation by intraoral structures. The optimal modeling duration ranges from 3 to 6 minutes, corresponding to the maximum time a patient can comfortably maintain the position without swallowing.

The modeling process will include excess material. The vertical excess is carefully removed just above the highest lingual contour line, corresponding to the maximum extent of lingual action. Excess material in front of the labial commissure has also been removed. The impression is then reinserted into the oral cavity to confirm proper adaptation and verify the accuracy of the adjustments.

Figure 5. Buccinator modeling.

Second step: Contralateral Buccinator Modeling (Figure 6)

The buccinator zone on the contralateral side is modeled using the same technique as the first side, with any excess material removed.

Before proceeding to the third step, the initial modeling must be repeated. This is because the patient's initial reaction to the material's introduction into the oral cavity, often surprise, can lead to inaccurate recordings. Consequently, the first impression may lack precision and reliability.

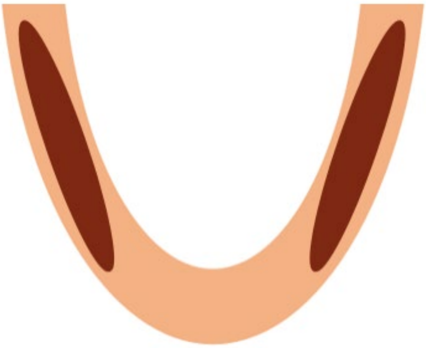

Figure 6. Final buccinator modeling.

Third Step: Anterior Modeling

The custom tray is loaded with material and inserted into the mouth. The patient is instructed to articulate specific phonemes. As she speak, excess material is expelled over the lower lip, creating a concave impression along its border.

For the anterior mandibular region:

Centrifugal tongue action is achieved by pronouncing "TE" and "DE".

Centripetal lip action is produced by articulating "SE", "ME", and "PE" [7].

Fourth step: Wash impression

Finally, a wash impression was performed using a highly flowable impression material Permlastic light®.

The impression is checked by asking the patient to speak and perform movements. It must remain stable and should not move or become dislodged (Figure 7).

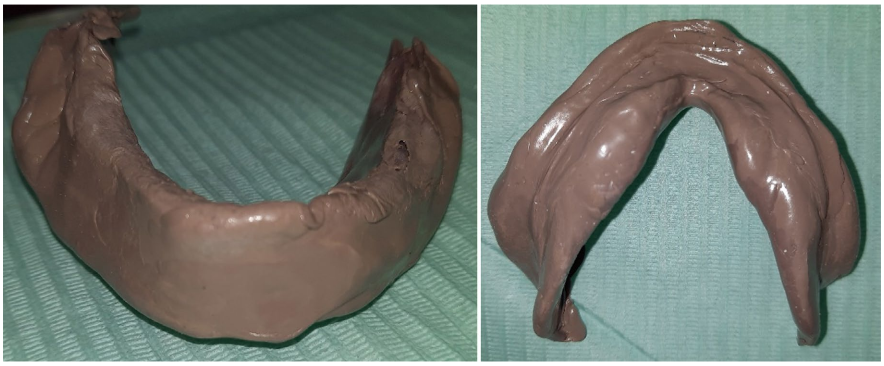

Figure 7. Final piezographic impression.

The impression is boxed and poured with dental stone. Before demolding the impression, retention grooves are created on the model, and indexes are made using a putty-consistency addition polyvinyl siloxane impression material (Figure 8).

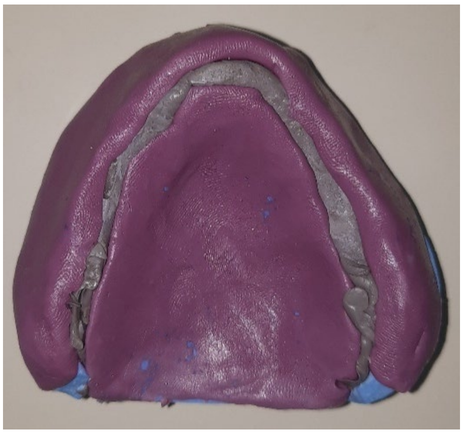

Figure 8. Silicone indexes using high viscosity elastomer.

The upper surfaces of the indexes must precisely align with the occlusal plane as defined by the piezographic recording. The impression is then demolded, and the piezography is set aside. The indexes are repositioned on the model, clearly revealing the exact volume of available prosthetic space and the Three-dimensional boundaries for prosthesis design. The defined space is then filled with molten wax to create the wax rim.

The silicone indexes are carefully removed, revealing an accurate wax reproduction of the piezographic recording.

The maxillomandibular relation is then recorded after determining the occlusal vertical dimension. The piezographic duplicate serves as the foundational template for optimal teeth positioning (Figure 9).

The trial prosthesis is evaluated intraorally with assessment of aesthetic parameters, phonetic function and occlusal stability.

Figure 9. Setting of artificial teeth.

Following polymerization, the prosthesis is inserted, and occlusal equilibration is carried out. The patient is then provided with oral hygiene guidance and prosthetic care instructions (Figure 10).

Figure 10. The patient's satisfaction smile after insertion of the prosthesis.

3. Clinical Case 2

A 62-year-old female patient was referred to the Department of Prosthodontics for bimaxillary prosthetic rehabilitation. Her primary concern was functional. Her medical history revealed a prior diagnosis of squamous cell carcinoma of the left hemiface, managed by surgical resection with clear margins followed by adjuvant radiotherapy.

Extraoral examination revealed a post-resection facial asymmetry, accompanied by a retracted scar on the left hemiface (Figure 11). Intraoral examination identified an atrophic, irregular, and asymmetrical mandibular ridge, significantly compromising prosthetic stability. The mucosa appeared fragile, likely as a consequence of late radiotherapy side effects, and the patient exhibited pronounced hyposalivation (**Figure 12**).

Clinical and radiological analysis classified the mandibular ridge as Sangiuolo Class III, associated with an unfavorable prognosis for conventional prosthetic rehabilitation.

Figure 11. Extraoral view showing facial asymmetry following surgery.

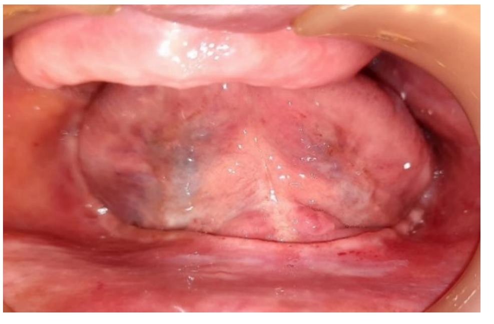

Figure 12. Intraoral view of the mandibular ridge.

Given the anatomical and functional constraints, a mandibular complete removable denture was fabricated using the piezographic technique to optimize stability and functional efficiency. This approach allows precise recording of the neutral zone and dynamic boundaries, which are essential for adapting the prosthesis to the patient's complex clinical condition.

A primary mucostatic impression was made using irreversible hydrocolloid (alginate) material in a commercial stock tray selected to accommodate the patient's radiation-induced mucosal fragility and mild trismus (**Figure 13**). The preliminary cast was used to create a 2 mm-thick auto-polymerizing resin baseplate, which was individually adjusted intraorally and verified for border extension and tissue contact, following the standardized protocol described in Case 1.

The piezographic impression was performed as follows. The adjusted baseplate was uniformly coated with light-bodied polysulfide impression material and inserted into the patient's mouth. To ensure precise muscle function recording, the patient performed a series of phonetic exercises. Buccinator activation was achieved by repeating /sis/ six times and /so/ once using standardized French pronunciation. Lingual dynamics were captured through the articulation of /te/ and /de/ to record centrifugal tongue movements. Finally, labial dynamics were recorded by producing /se/, /me/, and /pe/ to capture the centripetal forces exerted by the lips. These exercises were repeated until the material achieved sufficient rigidity, ensuring a stable and non-deformable impression.

Figure 13. Primary impression using irreversible hydrocolloid impression material.

Sequential material additions were made to establish optimal prosthetic volume boundaries.

Finally, to achieve a more accurate registration of the bearing surfaces, the entire recording was coated with polysulfide, and all the movements from the previous steps were repeated. This process ensured the completion of the piezographic impression (**Figure 14**).

Figure 14. Final piezographic impression.

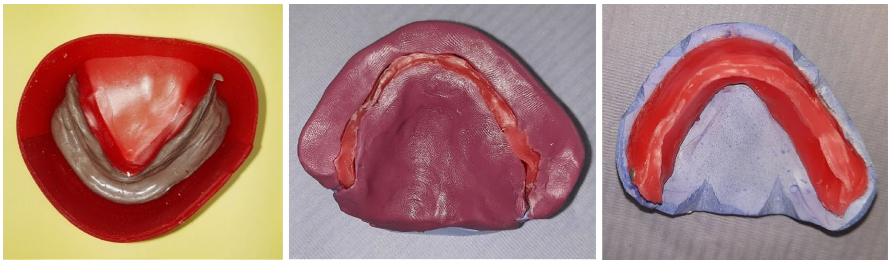

Figure 15. Boxing and wax duplicate creation.

Following the same protocol as previously described, the impression was boxed and poured with Type IV dental stone. Prior to demolding, vestibular and lingual indexes were created using putty-consistency polyvinyl siloxane to precisely delineate the neutral zone boundaries. These indexes served as a three-dimensional template for the prosthetic space (**Figure 15**).

The defined volume was then filled with molten modeling wax to create a duplicate that would serve as the base for mounting the prosthetic teeth after recording the intermaxillary relations (Figure 16, Figure 17).

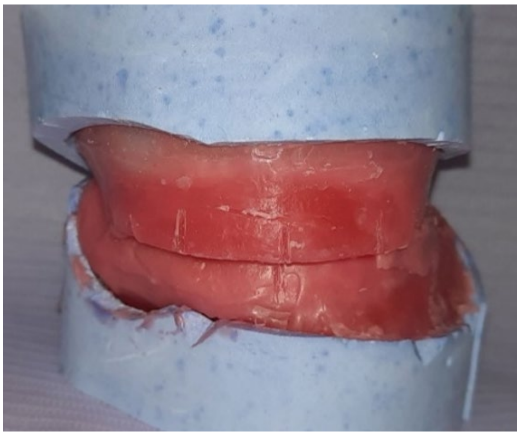

Figure 16. Maxillomandibular relationship records.

Figure 17. Mounting teeth.

The piezographic occlusion plane is determined by mandibular piezographic recording, rather than the usual maxillary approach.

On the posterior and lingual sides, this plane is located at the junction between papillary and smooth mucosa.

On the posterior vestibular side, it is Aligned with the convexity formed by the buccinator's horizontal fibers during lip protrusion.

At the anterior level, this plane is parallel to the lower lip's free border and simultaneously satisfies Aesthetic parameters and phonetic requirements.

Utilizing the piezographic technique, the mandibular prosthesis is designed to provide enhanced functional stability through anatomical conformity to dynamic oral structures and optimal force distribution across compromised tissues (Figure 18).

Prosthetic rehabilitation aims to restore the patient's masticatory function and optimize comfort while carefully considering the fragility of the irradiated tissues.

Figure 18. Extraoral view after prosthesis insertion.

4. Discussion

Conventional techniques for mandibular complete removable prostheses demonstrate significant limitations, particularly in rehabilitating atrophic or negatively contoured alveolar ridges. In such challenging clinical situation, piezography has emerged as a physiologically rational alternative that addresses these biomechanical deficiencies. This technique proves particularly valuable in geriatric prosthodontics, where advanced ridge resorption and compromised denture stability frequently coexist [4] [8] [9].

Advanced resorption of mandibular ridges leads to an increase in horizontal forces, which become extremely destabilizing for the prosthesis. The principle of piezography is: a thermoplastic material is precisely shaped by perioral muscular, in order to determine a zone of equilibrium in which the prosthesis must be constructed to achieve maximum stability, where the resultant of the horizontal forces developed by the tongue and buccinato-labial strap must not exceed the retention of the prosthesis. $F_{retention} \geq (F_{tongue} + F_{buccinator} + F_{labialis})$

The piezographic technique is therefore the treatment of choice to overcome prosthetic instability in many patients, not only in cases of advanced bone resorption, but also in patients with high muscle tone or impaired neuromuscular control [10].

Among the various piezographic modeling techniques, phonation and swallowing seem to be the most commonly used functions. Phonation involves all the mandibular muscular movements performed during swallowing and mastication. The pronunciation of different phonemes activates all the muscles of the orofacial sphere. Phonation is, therefore, the most precise, simple and easy-to-control technique [11].

P. Klein highlighted the usefulness of phonation as the primary vector for piezographic modeling. He used a sequence of specific phonemes ("sis, sis, so, te, pe, de" French pronunciation), repeated by the patient until the modeling material reached a point of stability and was no longer modifiable. The effectiveness of this modeling can be adjusted based on the patient's muscle tone, for example, by replacing the "e" with an "i" or an "o", or substituting the "me" with a "pe" for a more vigorous modeling [12].

Compared with traditional techniques, piezography offers many advantages. It offers greater reproducibility of bearing surfaces. It is also simpler to perform, reducing the difficulties associated with the use of thermoplastic materials [13].

Another relevant field of application for piezography is the management of cases of lingual and mandibular loss of substance following cancer surgery. In these situations, prosthetic realization is often complicated by major alterations in anatomical structure and muscle deficit. Piezography offers a personalized solution by defining a prosthetic space adapted to these new biomechanical constraints. It thus optimizes the distribution of muscle forces and improves prosthetic stability, even in such complex clinical contexts [14].

The two cases presented illustrate the relevance and effectiveness of this technique. In the patient with severe mandibular resorption, piezography helped establish a precise and functional neutral space. In the second case, despite anatomical alterations resulting from resective surgery, piezography contributed to designing a prosthesis perfectly adapted to the patient's specific constraints. These results confirm the importance of this approach in enhancing comfort, masticatory function, and the quality of life for patients.

Advances in computer-aided design (CAD) now allow for easy modification of the position of virtual teeth within the piezographic space using CAD software, representing a significant advantage [15].

The aim of prosthetic treatment using piezography is to ensure stability by placing the prosthesis in its prosthetic space, allowing the peripheral musculature to promote equilibrium. Treatment with an implant-supported mandibular overdenture enhances retention.

The combination of piezography and implantology is a particularly relevant complementary approach to the rehabilitation of completely edentulous patients. The piezographic prosthesis integrates perfectly into the patient's physiological context. When combined with implantology, this technique promotes greater stability and retention of the complete removable prosthesis [16].

However, piezography has certain limitations: it is time-consuming, technically challenging, and requires full patient cooperation. Additionally, it may necessitate vestibulo-lingual reduction of teeth and occlusal surfaces when the prosthetic space is particularly narrow [17].

5. Conclusion

The rehabilitation of total mandibular edentulous patients, particularly in cases of advanced bone resorption or substance loss following surgical interventions, remains a major challenge in removable complete prosthetics. The piezographic technique, especially the phonetic approach, has proven to be an effective and innovative solution to meet this challenge. By precisely recording the dynamic functional limits, this method allows for optimal prosthetic adaptation and ensures better stability and retention, even in complex clinical cases.

Conflicts of Interest

The authors declare no conflicts of interest.

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