Retention of a speech-aid prosthesis with a magnetic attachment in a patient with cleft lip and palate: A case report

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Abstract

This report describes a case in which insufficient remaining teeth impacted the effectiveness of maxillofacial prosthetic rehabilitation and reports on the applicability of magnetic attachments for the retention of dentures equipped with speech aids. This method is aimed at improving the stability and functionality of these dental prostheses. A 75-year-old woman with velopharyngeal dysfunction due to left maxillary cleft lip and palate presented with an unstable maxillary overdenture equipped with a speech aid, which had a disengaged O-ring attachment on the left maxillary central incisor. It was replaced with a magnetic attachment and the speech-aid prosthesis was adjusted. Functional evaluation was performed with the adjusted prosthesis, and a significant reduction in nasalance during speech was observed. Assessment of masticatory performance demonstrated that the patient could eat a wide variety of foods without substantial difficulty. The magnetic attachment was weak against lateral force, but it improved tongue comfort compared with the O-rings when the prosthesis was not in use. Further discussion and consideration of the effective use of magnetic attachments in maxillofacial prosthetics is expected.

Introduction

Effective maxillofacial prosthetic rehabilitation can be challenging due to insufficiency of the remaining teeth, which can impact the stability and function of the appliances. To address this challenge, one method being explored is the use of magnetic attachments in maxillofacial prosthetic appliances. These attachments could potentially improve oral functions and enhance retention and stability[1-3]. In this report, we describe a case in which magnetic attachments were used for the retention of a speech-aid-equipped denture. This method was chosen to reduce the difficulties encountered in maintaining the stability and functionality of this type of dental prosthesis.

Case Report

Patient Characteristics

The patient was a 75-year-old woman who presented in September 2022 with a chief

complaint of instability in her speech-aid-equipped maxillary overdenture and difficulties in verbal articulation and mastication. She had dysfunctional velopharyngeal closure due to left maxillary cleft lip and palate, with partially edentulous maxillary and mandibular arches (Fig. 1). The O-ring attachment on the left maxillary central incisor had become dislodged causing instability of the maxillary overdenture.

Fig. 1 Panoramic X-ray of the upper and lower jaws.

Clinical History

The patient was born with a cleft palate and subsequently underwent palatoplasty and speech therapy. In the mid-1960s, a speech aid was fabricated at our institution for the patient. Around twenty years later, following fracture of this speech aid, the patient consulted our university's department of oral surgery and was then referred to our advanced prosthodontics department for initial consultation and examination. After the initial consultation, a speech-aid-equipped maxillary partial denture was fabricated, and the patient attended regular follow-up. However, progressive tooth decay and periodontal disease led to a gradual decrease in her remaining teeth. In response to these changes, a new speech-aid-equipped partial denture was fabricated and adjusted on four occasions to accommodate her evolving dental status. Figure 2 shows the condition of the oral cavity and the speech-aid-equipped partial denture as of 2003.

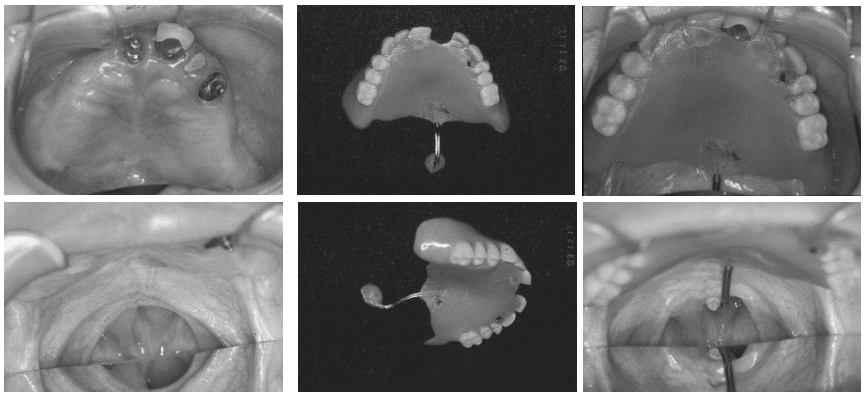

Fig. 2 Intraoral and extraoral views and the speech-aid-equipped partial denture (2003).

Treatment Plan

Treatment that utilized the existing speech aid denture was planned. We detailed the anticipated advantages and disadvantages[4] of using a magnetic attachment for the left maxillary central incisor and obtained the patient's consent for this treatment.

Materials and Methods

In accordance with standard procedures, the left maxillary central incisor was prepared (utilizing the existing posts) and an impression was made (Exafine Regular, GC). A magnetic attachment keeper (Magfit M, Aichi Steel) was then installed using Super-Bond (Super-Bond, Sun Medical)(Fig. 3). A pathway was created in the speech-aid-equipped overdenture, and a magnet was attached to the denture. The magnet was set using immediate polymerization resin (Unifast III, GC)(Fig. 4). After adjustments, we conducted a series of functional evaluations, focusing on speech intelligibility, masticatory performance, and denture stability and the patient's satisfaction with the denture.

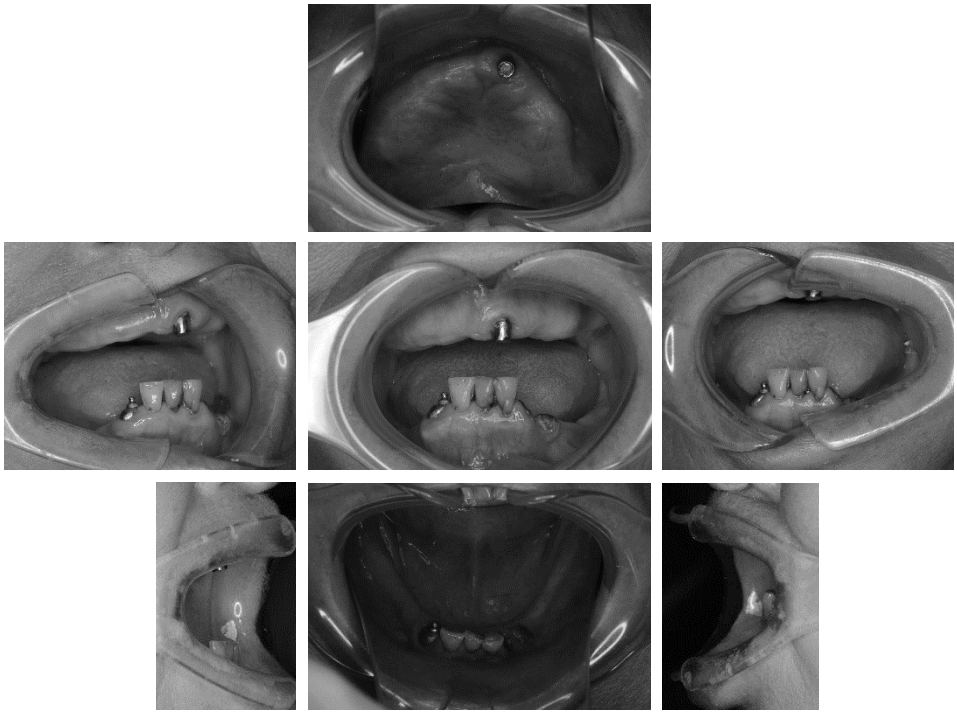

Fig. 3 Intraoral view with a magnetic attachment keeper on the left maxillary central incisor (2023).

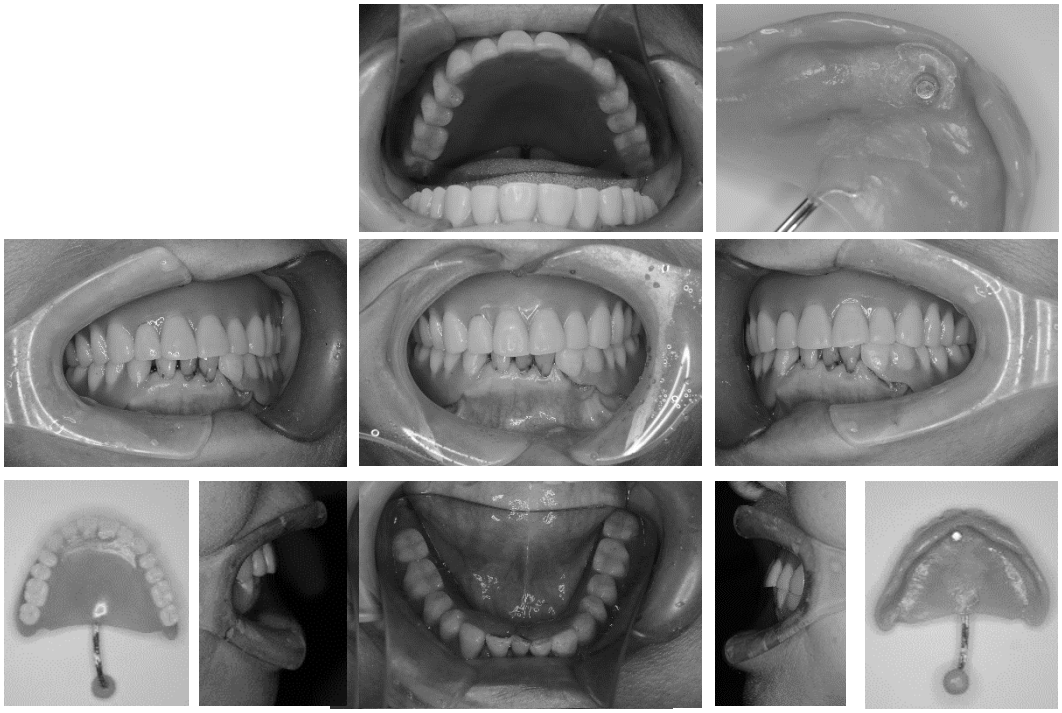

Fig. 4 The fabricated speech aid with a magnetic attachment in place (2023).

Functional Evaluation

Masticatory Performance Evaluation: Objective Food-Comminuting Ability

Masticatory performance[5] was assessed by measuring the concentration of dissolved glucose from a gummy jelly (Glucolumn, GC). The patient was instructed to masticate the gummy jelly for 20 s, rinse with 10 mL of distilled water, and expectorate the masticated particles into a filter net within a cup. The resultant filtrate was then gathered, and the glucose concentration released from the fragmented gummy jelly was precisely measured using a portable blood glucose meter (Glucosensor GS-II, GC).

Masticatory Performance Evaluation: Objective Food-Mixing Ability

We used color-changeable chewing gum (Xylitol, Lotte) (70 mm × 20 mm × 1 mm, 3.0 g), to assess masticatory performance in relation to food mixing[6]. For a specified duration of 1 min, the patient was asked to chew the gum and then the specimen was collected immediately after mastication. The a* and ΔE_{1min} values were obtained by measurements using a colorimeter (CR-13, Konica-Minolta Sensing).

Masticatory Performance Evaluation: Subjective Perceived Chewing Ability

The patient's perception of chewing ability was assessed using a food intake questionnaire[7]

consisting of a list of 35-food items divided into 5 categories based on hardness of the food and rated in relation to ease of eating. To describe masticatory ability using the questionnaire, Masticatory Score was calculated as the sum for the 5 categories of the total points in each category multiplied by a difficulty factor, and then the Masticatory Score was expressed as a percentage of this value out of the maximum possible.

Lip-Closure Strength Evaluation

The lip-closure strength was measured as the force-resisted by the device while pulling the tightly closed lips, using a digital strain force gauge (Lipplekun, Shofu) as previously described[8].

Denture Satisfaction Evaluation

The patient completed the self-rated Denture Satisfaction Questionnaire[9], which uses a visual analog scale, to systematically evaluate critical facets of her prosthetic experience, encompassing masticatory functions, such as eating and chewing efficiency, as well as the impact of the prosthesis on facial esthetics and speech intelligibility. In addition, an overall satisfaction metric was included to capture a comprehensive appraisal of her denture use.

Digital Acoustic Analysis: Formant Frequency Evaluation

Digital acoustic analysis of five Japanese vowels, (/a/, /i/, /u/, /e/, /o/) and uttered sounds were recorded using a speech analysis system (Computerized Speech Lab CSL4500, Kay Pentax). Acoustic analysis was performed using sound analysis software (Computerized Speech Lab, Kay Pentax). The ranges of the first two formants were determined by calculating the difference between the minimum and maximum formant frequencies among the five vowels[10].

Digital Acoustic Analysis: Nasalance Evaluation

Nasalance, defined as the ratio of acoustic energy of speech sounds emanating from the nasal cavity relative to that from the oral cavity, was measured using a nasometer (Nasometer II, Kay Pentax) while the patient enunciated the monosyllables /i/, and /tsu/, sentence with low vocal pressure, sentence with high vocal pressure and mixed-content sentence[11].

Results

The patient reported that tongue sensation was more favorable with the magnetic attachment than with the O-ring attachment when she was not wearing the prosthesis. She complained that the speech-aid-equipped overdenture (Fig. 4) tended to dislodge when lateral forces were applied, so adjustments were made to the pressure distribution of the denture by reattaching the magnet on two occasions. However, no improvement was observed.

The patient's lip-closure strength was 11.7 N, surpassing the established minimal requisite of 6 N and the targeted optimal level of 10 N. In addition, her masticatory performance was evaluated by multiple methods. Objective food-comminuting ability, an indicator of effectiveness in breaking down food, was measured as 160.3 mg/dL, greatly exceeding the benchmark of 100 mg/dL. The objective food-mixing ability values were ΔE of 58.4 and a* of 30.2. Complementing these objective evaluations, the patient's subjective chewing ability was appraised in terms of Masticatory Score as 79.8%. This comprehensive evaluation shows a marked improvement in oral functionality, which is attributed to the speech-aid-equipped overdenture with magnetic attachment, which enabled the patient to eat a wide variety of foods without major difficulties.

The range of formant 1, 2 and 3 when prosthesis was worn were 646.83, 2022.05 and 731.2 Hz, and those when prosthesis was not worn were 569.65, 1609.41 and 871.38 Hz respectively. The range was sufficient to distinctly articulate and differentiate the five vowels, indicating adequate articulatory function. Most notably, the incorporation of the denture with a speech aid was correlated with significant enlargement of the range of the third formant. This change in the acoustic parameters suggests a potential improvement in nasopharyngeal function, which is a critical factor in articulation and thus speech intelligibility.

The implementation of a denture equipped with a speech aid led to a decrease in nasalance (Fig. 5). This reduction was particularly pronounced in the average nasalance values associated with the articulation of high-pressure sounds and mixed-content sentences. This notable decrease in nasalance is indicative of enhanced efficiency in nasopharyngeal closure, suggesting functional improvement of the velopharyngeal mechanism as a result of prosthetic treatment.

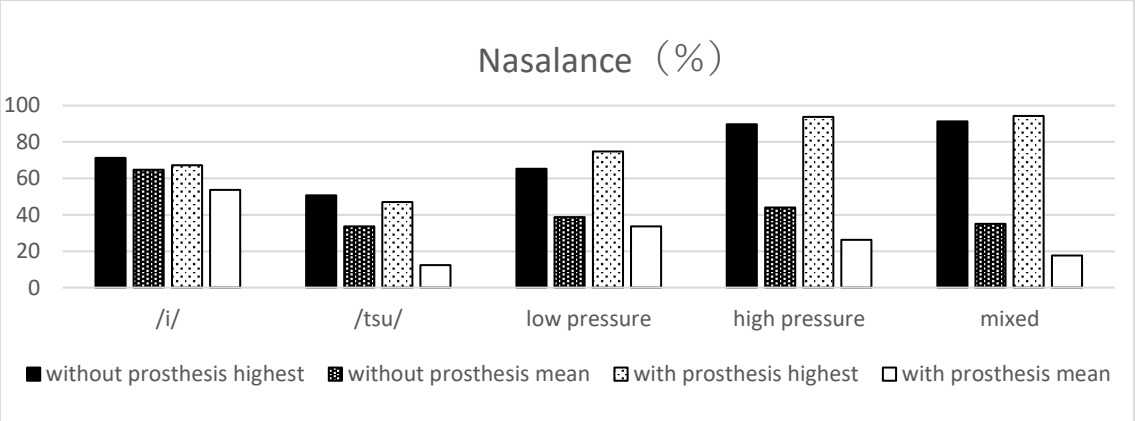

Fig. 5 The result of nasalance test.

The patient's satisfaction with the denture was high, particularly in relation to masticatory function, such as eating and chewing efficiency, as well as the 'impact of the prosthesis on facial appearance and speaking (Fig. 6).

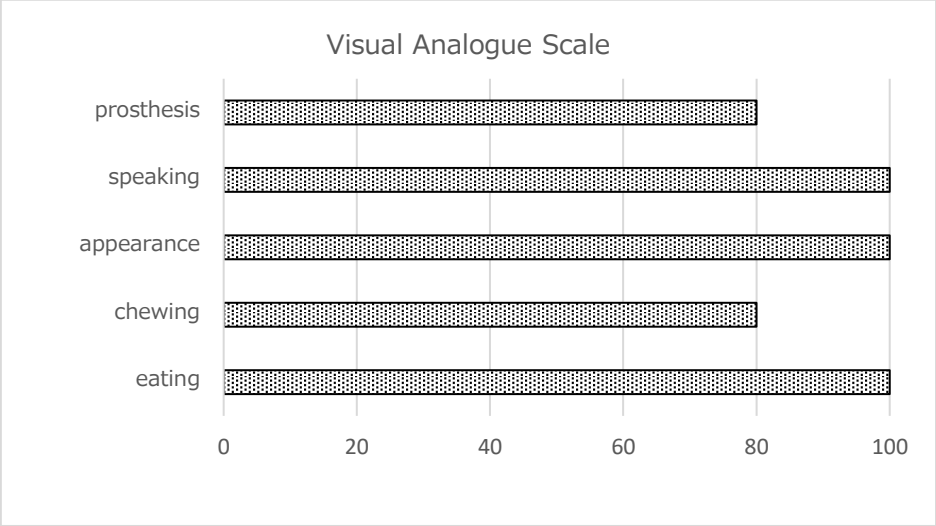

Fig. 6 The result of visual analogue scale.

Discussion

The magnetic attachment, while offering a superior tactile experience compared with the O-ring attachment, showed a tendency for the denture to dislodge under lateral forces. Despite this, the integration of a magnetic attachment with the speech-aid-equipped overdenture markedly improved nasopharyngeal closure and articulation, and also enabled the patient to eat of a wide variety of foods. This comprehensive treatment approach resulted in a high degree of patient satisfaction.

Conclusion

In this patient with cleft lip and palate, the incorporation of a magnetic attachment in a speech-aid-equipped denture demonstrated substantial functional rehabilitation. However, a notable challenge was the attachment's susceptibility to lateral forces. Therefore, ongoing research and development in this domain is needed to enhance the effectiveness and therapeutic potential of magnetic attachments in maxillofacial prosthetic applications.

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