Critical Review: Are prosthetic appliances for velopharyngeal dysfunction in cleft palate effective for improving speech intelligibility?

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This critical review examines the evidence regarding the impact on speech intelligibility with the use of a prosthetic device for cleft palate patients presenting with velopharyngeal dysfunction following primary surgical intervention. Study designs include case study, between group, and single group studies. Overall, the evidence gathered from this review suggests improvement in speech intelligibility following the insertion of a prosthetic device with speech therapy. Recommendations for future research and clinical practice are provided.

Introduction

Velopharyngeal dysfunction (VPD) is the inability to completely close the nasal airway during speech (Woo, 2012). VPD can be categorized as velopharyngeal incompetence (VPI), a physiological deficiency resulting in poor movement of the velopharyngeal structures, or velopharyngeal insufficiency, an anatomical deficit resulting in poor velopharyngeal closure due to structural deficiencies (Kummer, 2014). VPD following surgery for cleft palate repair occurs in 20-30% of cases, and such cases are often associated with negative outcomes for speech production. (Woo, 2012; Ha, Koh, Moon, Jung, & Oh 2015). As reported by Woo (2012), VPD may be characterized by hypernasality, nasal emission, decreased vocal intensity, facial grimacing, as well as compensatory articulation strategies all resulting in decreased intelligibility.

Current treatment methods for individuals with VPD following primary surgery consist of secondary surgery, the use of prosthetic devices, as well as speech therapy. Although a potential treatment option, secondary surgery is not suitable for all patients due to various contradictions (Pinto, Dalben, & Pegoraro-Krook 2007). According to Pinto et al. (2007), prosthetic devices can be used in these instances to improve velopharyngeal closure. Prosthetic devices in individuals with VPD can compensate for minimal movement of the pharyngeal walls, reduce the structural opening separating the oropharynx from the nasopharynx, as well as compensate for insufficient palatopharygeal tissue during speech and feeding (Bispo, Whitaker, Aferri, Neves, Dutka, & Pegoraro-Krook 2011; Agrawal, Singh, Chand & Patel 2011; Shin & Ko 2015). As not all individuals presenting with VPD are eligible for a secondary surgery, it is imperative to explore effective, non-surgical treatment options in order to increase speech intelligibility. Pharyngeal/palatal obturator, speech bulb, and palatal lift prostheses are removable prosthetic devices used to achieve closure of the velopharyngeal port. A pharyngeal obturator has a superiorly located acrylic extension used to cover an open palatal defect such as a palatal fistula. A speech bulb, also known as a speed aid appliance, sits in the nasopharynx to occlude the VP port for speech. A palatal lift prosthesis elevates the velum and holds it in place against the posterior pharyngeal wall (Kummer, 2014). The literature investigating the use of a prosthetic device to increase speech intelligibility in individuals with cleft palate suggests that it is a valid treatment option for patients not suited for a secondary surgery.

Objectives

The purpose of this study is to critically appraise existing literature to examine the effects of prosthetic appliances on speech intelligibility for patients with VPD following cleft palate surgery.

Methods

Search Strategy

Articles related to the topic were found on the computerized database PubMed. Key words for the database search were as follows:

[(velopharyngeal dysfunction) OR (velopharyngeal insufficiency) AND (cleft palate) AND (prosthetic device) OR (speech obturator) AND (speech intelligibility)].

The search was limited to articles written in English.

Selection Criteria

Studies selected for inclusion in this critical appraisal were required to investigate the effect of any type of prosthetic device on speech intelligibility for VPD following cleft palate surgery. There were no limitations set on the demographics of the research participants due to a potentially small sample size.

Data Collection

The results of the literature search yielded the following types of articles in line with the selection criteria mentioned above: case study (3), single-group study (2), and between group study (1).

Results

Case Study

Case studies are used to conduct research for a small population, and as such, are appropriate for examining cases of cleft lip and palate treatment. Results from case studies cannot often be generalized to a larger group resulting in a weak level of evidence, but can provide direction for further research.

Agrawal et al. (2011) conducted a case study of a 19-year old male with history of cleft palate and pharyngeal flap repair to determine if the use of a pharyngeal obturator with speech therapy results in decreased nasal regurgitation and increased speech intelligibility, only results pertaining to the latter will be discussed here. Patient profile was well-described, however recruitment details were not provided. A perceptual assessment of nasal resonance and overall speech intelligibility were completed by a speech-language pathologist, otolaryngologist, prosthodontist, and an unfamiliar listener prior to the fitting of a pharyngeal obturator and subjective data were collected. The patient completed three weeks of speech therapy, at which point post-intervention data were collected with and without the use of the pharyngeal obturator. Although measures of speech intelligibility were reported, the task employed was not described.

Authors reported improvement in both hypernasality and speech intelligibility with the pharyngeal obturator in place. No objective data or subjective rating scales were reported as evidence for this conclusion.

Although this study addresses the improvement of speech intelligibility due to the insertion of a pharyngeal obturator and short-term speech therapy, findings provide somewhat suggestive evidence in light of the considerable caution warranted given the lack of detail in the report.

Shin et al. (2015) conducted a case study of the relationship between the implementation of a speech bulb with speech therapy and decreased nasalence scores on vowels in a 16-year old female with a repaired incomplete cleft palate. Details regarding the recruitment process were not noted, however the female's profile was well described. Commonly employed gold standard measures of assessments were used to obtained speech and voice data pre- and post-intervention, and objective measures of simple vowels and diphthongs were assessed using a nasometer. Using well detailed criteria for potential treatment, a speech bulb prosthesis with intensive speech therapy was recommended and implemented for the participant. The speech bulb was fitted to the participant and a two-week adaptation period was provided. Nasometric assessment was conducted 2, 4, 6, 8, 12, 16 and 20 weeks post insertion. The nasalence score decreased significantly after 2 weeks of use, and remained stable through to re-assessment at 20 weeks. A consistent decrease in the amount of nasalence lead to subject satisfaction however, the subject discontinued the use of the appliance due to sensory irritation 5 months after the initial insertion.

Using descriptive statistics only, nasalence continued to decrease throughout the intervention period. However, only three vowels determined to have high nasalence during the pre-intervention data collection were analysed in detail. Although the findings were taken as evidence in favour of speech bulb prosthesis with speech therapy for reducing nasalence, they may not generalize to other speech sounds beyond the target vowels. The authors reported that the effectiveness of the speech bulb prosthesis could also be due to the fact that vowel /i/ was more severe in hypernasality than other vowels, and the speech aid and therapy could be targeted to specifically improve this error. Any impact on speech intelligibility generally can only be inferred from this finding.

Although this study shows a relationship between the speech bulb prosthesis with speech therapy and a decreased nasalence score in vowels, the results of the study cannot be generalized to all speech sounds. As a result, the findings provide limited suggestive evidence for the use of a prosthesis in improving speech intelligibility for individuals with VPD.

Bispo et al. (2011) conducted a case study design to determine the effectiveness of intensive speech therapy with a speech bulb appliance and its implications on speech intelligibility. The participant was a 6-year old female with history of repaired unilateral cleft lip and palate who presented with VPI after primary palatal surgery. Information on recruitment criteria was absent, however the female participant's profile was well-described. Gold standard assessment measures of speech, and velopharyngeal function were reported. The participant completed 3 phases (2 sessions of 50 minutes per day for two weeks) of speech therapy

with the speech bulb, however duration between phases was not specified. Treatment phases were initiated after an appropriate speech bulb was designed for the patient. The first 2 phases of intensive speech therapy with the speech bulb included targeting the oral place and production for all speech sounds, and the last phase focused on producing adequate velopharyngeal function with the use of the appliance. The family and child were trained so that sounds targeted in speech therapy were being practiced and monitored at home between each treatment phase. After the 3 phases of speech therapy with the speech bulb, a speech bulb reduction program was implemented by a dentist and speech-language pathologist. During the speech bulb reduction program, speech therapy continued while the dentist continually reduced the size of the prosthesis until the function of the velopharyngeal structures was optimal and zero nasal air leak remained.

Assessments listed with a phrase description included many commonly employed measures, however no details regarding the data collection were provided. Results were reported using categorical and descriptive labels before and after intervention. The participant was a native Brazilian-Portuguese speaker, and findings may not generalize to an English speaking patient. Authors interpret their descriptive results as indicating that successful prosthetic treatment relies on multiple factors, including the patient's degree of hypernasality, age, dental conditions, type of articulation errors used, and the structure and function of the pharyngeal walls. The reported treatment method included diligent teamwork with the dentist, speech-language pathologist, the family and client. Therefore, the prosthetic device in isolation was not the only factor for the improvement in intelligibility.

Although the findings are suggestive of improved speech intelligibility with the use of a speech bulb with speech therapy, considerable caution is warranted given the lack of detail in the report.

Between Groups

Between group studies are used to conduct research on two groups simultaneously, comparing results resulting in a somewhat strong level of evidence. However, generalization may be limited depending on the sample size.

Pinto et al. (2007) conducted a between group study to compare treatment effects for prosthetic speech devices on speech intelligibility in patients with history of cleft palate with or without surgical intervention. Patients were recruited through a referral process for speech prosthetic treatment and met well specified inclusion criteria. A total of 27 patients were divided in to two groups; those who have had surgical intervention for cleft palate repair and present with VPI after primary palatal surgery, and those who have not received surgical intervention to repair cleft palate. The operated patients received a speech bulb prosthesis, whereas the unoperated group received a palatopharyngeal obturator, except 2, who received another device. Improvements in speech intelligibility were measured by perceptual judgement made by experienced speech-language pathologists. Acceptable inter- and intra-rater reliability were reported. Evaluation of speech intelligibility was assessed using perceptual evaluation 6 months after insertion of the prosthetic device.

Appropriate non-parametric statistical analysis compared each group separately at pre- and post-insertion of the prosthesis. Overall, results revealed significant improved speech intelligibility which was reflected in the majority of individual patients. Presence of a prosthetic device alone had no effect compensatory articulations, nasal air emission and misarticulation leading the researchers to suggest that speech therapy may have decreased the use of poor articulatory habits, and improved intelligibility overall.

This study has many strengths and provides highly suggestive evidence for the use of a prosthetic device resulting in reduced speech intelligibility regardless of surgical intervention. It is of note, however, that this treatment may not be sufficient on its own and should be accompanied by speech therapy.

Single Group Study

In single group studies, participants act as their own control. Generalization of treatment effects to a broader population is one limitation of single group studies, resulting in a weaker level of evidence.

Raju, Padmanabhan and Narayan (2009) conducted a single group design to assess the effect of a palatal lift prosthesis on speech intelligibility of cleft palate patients treated with pharyngeal flap surgery. Using well-specified recruitment criteria, 7 patients (16-26 years) were recruited with typical speech and language abilities, no improvement of hypernasality and speech intelligibility following surgical intervention, normal hearing, nasoendoscopic examination as well as the ability to fluently speak Tamil. Speech assessment using subjective, perceptual evaluation by trained speech-language

pathologists as well as objective gold standard assessment measures such as nasoendoscopy and nasometry were used to assess hypernasality and speech intelligibility. The palatal lift prosthesis was fitted for each patient and speech samples with and without the prosthetic device in place were taken in a noise-free environment immediately after insertion, at the end of months 1, 2, and 3 of wearing the device, as well as one month after the removal of the prosthesis.

Outcome measures were compared across study time using multiple t-tests and showed no significant difference for the perceptual measures, but significantly reduced hypernasality relative to pre-prosthetic measures after three months. Reduced nasalence in oral versus nasal sentences was reported for three and four months post placement of prosthesis using an ANOVA, although corresponding results for other time points were not reported. The use of multiple t-tests to assess changes in nasometry and lack of detailed reporting of some analyses are limitations of this study. Evaluation of speech intelligibility and nasometry were completed in the Talim language, and may not generalize to English speaking patients.

This study provides suggestive evidence for improvements in hypernasality and nasalence with the use of palatal lift prosthesis in patients with history of surgical intervention for cleft palate.

Aboloyoun, Ghorab and Farooq (2013) conducted a single group, retrospective study to determine whether a palatal lift prosthesis in children with history of cleft palate repair improved VPI as measured by speech evaluations. Based on reasonable, well-specified criteria, 10 participants (8-10 years) were recruited. The participants were also tested using commonly employed formal and informal assessments to ensure suitability for a palatal lift prosthesis. Baseline data prior to the insertion of a palatal lift, re-evaluation 48 and 72 hours post application insertion, and final evaluation after 2 months were obtained using gold standard measures of articulation, nasality and intelligibility rated on a scale from normal to severe. Improvement was classified using categorical yes/no evaluation.

Appropriate statistical analysis for categorical data revealed significant improvement of glottal articulation, facial grimace, hypernasality and speech intelligibility following the insertion of a palatal lift prosthesis with speech therapy through to 2 months post insertion. More detailed description of the patient's improvement in these two areas would have clarified the relationship between the two variables.

Given the appropriateness of the study design and methods for the question, this study provides suggestive evidence that there is an improvement in speech intelligibility after two months use of the palatal lift prosthesis with speech therapy.

Discussion

The question of whether prosthetic appliances improve speech intelligibility for individuals following cleft palate surgery has been critically reviewed. The current research provides suggestive evidence of improved speech intelligibility following a palatal prosthesis insertion. Palatal prosthesis in conjunction with speech therapy have been shown to reduce hypernasality, decrease nasalence and nasal regurgitation, and improve speech intelligibility (Agrawal et al., 2011; Shin et al., 2015; Bispo et al., 2011). However, some cases of prosthetic insertion with or without speech therapy were not successful in improving speech intelligibility through perceptual evaluation. The reviewed research however, was conducted with small sample sizes, and report descriptive statistics only. Therefore, findings in this research cannot be generalized to the cleft palate population as a whole; further research should be conducted on larger populations. Speech therapy, although recommended and implemented in some of the reviewed research was not included in all. Of the research that included speech therapy, positive effects on speech intelligibility was concluded.

<u>Future Research:</u>

It is recommended that further research be conducted to confirm the effectiveness of a prosthetic device for speech intelligibility for patients with velopharyngeal dysfunction in cleft palate. In future studies, the following recommendations should be considered to strengthen the level of evidence:

1. Future research studies should employ study designs that lend stronger levels of evidence and incorporate larger sample sizes to increase confidence and generalizability of clinical implementation.

2. Research should explore the effect of a prosthetic appliance for speech intelligibility for individuals with VPD with and without speech and language intervention.

3. Researchers should consistently employ objective approaches to the analysis of relevant data.

Conclusion

With reasonable consistency, prosthetic devices with speech therapy show reduction in hypernasality, nasalence, nasal regurgitation and improved speech intelligibility (Agrawal et al., 2011; Shin et al., 2015; Bispo et al., 2011). Somewhat suggestive evidence that higher success rates were associated with speech therapy, yet further research is required.

Clinical Implications

Due to the limited strength of evidence provided by the articles reviewed, important findings were reported and can be used for further research. Based on the findings, clinicians should use caution when recommending a prosthesis device to improve speech intelligibility caused by VPD following cleft palate. Clinicians must understand the heterogeneity of the population and individual analysis is required when implementing a prosthetic device; a standard therapy protocol will not be successful with all patients. Based on the potential success of a prosthetic device with speech-language intervention, it is imperative to continue to study treatment effectiveness and generalization.

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