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Tongue-Pressure Resistance Training: Workout for Dysphagia

by Catriona Steele

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Tongue-pressure resistance training has recently emerged as a focus in dysphagia rehabilitation. Although debate continues on the effectiveness of oral-motor exercises for rehabilitating speech and swallowing, tongue-pressure resistance training addresses some of the concerns about more generic oral-motor exercise in two ways. First, the task of compressing an air-filled bulb between the tongue and the palate mimics the way that the tongue behaves during liquid swallowing, giving the task better specificity than other exercises. Second, the design of current treatment protocols is based on evidence from the world of sports medicine and exercise physiology. They consider issues such as exercise intensity, load, and fatigue in determining an appropriate schedule and duration of treatment.

Research and Rationale

The rationale behind using tongue-pressure resistance exercises is that the tongue is built of skeletal muscle, which may become weak with age or as a consequence of disease, and which may respond to load-bearing exercise like other skeletal muscles. The evidence for this rationale comes largely from the work of SLP JoAnne Robbins, who has studied age-related changes in tongue-pressure capacity. Maximum isometric tongue-pressures (MAXTPs), which involve compressing an air-filled bulb against the palate as hard as possible, are thought to decline with age. In a seminal study in this area (Nicosia et al., 2000), Robbins and her colleagues showed that 10 healthy seniors (mean=81 years) had significantly reduced MAXTPs compared to 10 middle-aged adults (mean=51 years).

Interestingly, however, these data did not show an age-related reduction in tongue-pressure amplitudes during swallowing tasks ("swallowing pressures"). Swallowing pressures typically fall below 50% of MAXTP values; the amplitude difference between habitual swallowing pressures and MAXTP has become known as functional reserve, and is thought to decline in healthy aging (Ney, Weiss, Kind, & Robbins, 2009).

Recently, however, evidence of age-related declines in MAXTPs and functional reserve has been called somewhat into question by Youmans, Youmans, and Stierwalt (2009). In a larger study of 96 healthy adults aged 20–80, the researchers reported an overall mean MAXTP value of 563 mmHg, and a statistically significant, but small, negative correlation ($r = -0.41$) between age and MAXTP. When swallowing pressure amplitudes were converted to a percent of MAXTP, older and younger participants did not differ significantly, suggesting preservation of functional reserve. A recent study in Japan (Utanohara et al., 2008) also examined MAXTP in a large sample of 853 healthy adults, and showed small but significant negative correlations with age (r = -0.1 and -0.33) in women and men, respectively.

Effects of Resistance Exercise

Regardless of whether tongue-pressure capacity actually declines with age, a second important question is whether tongue-pressure measures change as an outcome of resistance exercise. Proof-of-principle for this approach was first established by Lazarus, Logemann, Huang, and Rademaker (2003) and by Robbins et al. (2005), who showed that eight weeks of tongue-pressure resistance exercise increased tongue pressures in healthy young and older adults. In the Robbins study, 10 healthy seniors progressed from mean MAXTPs of 307 to 368 mmHg, a 20% improvement. These values contrast with reported mean MAXTPs for healthy adults of 560–600 mmHg (Nicosia et al., 2000; Youmans et al., 2009).

Reduced maximum tongue-pressure amplitudes are a frequent finding in people with neurogenic dysphagia. Robbins used tongue-pressure resistance training in 10 adults with dysphagia in the first six months post-stroke (Robbins et al., 2007). These patients began treatment with markedly reduced MAXTPs (mean=267 and 227 mmHg at the anterior and posterior palate, respectively). Like the seniors in Robbins' previous study, these individuals had improved tongue-pressure amplitudes (389 mmHg anterior; 410 mmHg posterior) after eight weeks of treatment. In our own lab, we have measured MAXTPs in a series of 26 patients with neurogenic dysphagia; at the beginning of treatment, these individuals had significant reductions in MAXTP at the anterior (252 mmHg) and posterior palate (216 mmHg), compared to published norms (560–600 mmHg).

Impact on Swallowing

It seems to be less clear whether improvements in tongue-pressure capacity generalize to improvements in swallowing. Part of the dilemma is in deciding which specific features of swallowing physiology are most likely to respond. In her study of stroke patients (Robbins et al., 2007), Robbins chose to measure swallowing safety using the Penetration-Aspiration Scale (Rosenbek, Robbins, Roecker, Coyle, & Wood, 1996) and a standardized videofluoroscopy protocol, and mean penetration-aspiration scores across the group of patients were reported to improve. Robbins also measured vallecular and pyriform sinus residue, but improvement was less consistent in these measures. Part of the challenge in trying to demonstrate robust treatment outcome trends in research is finding patients with similar physiology at the outset. Patients with reduced tongue-pressure capacity do not necessarily all look the same on videofluoroscopy, although certain patterns might be expected.

In our lab, we believe that patients who have poor oral control of thin liquid boluses are likely to be suitable for tongue-pressure resistance training. We would also recommend this approach for patients with vallecular residue, which we believe reflects weak tongue propulsion of a bolus. We are conducting a case series study of tongue-pressure resistance training in patients with these specific impairments secondary to stroke and acquired brain injury. So far our results concur with those of Robbins in that MAXTP values are improving; we are less convinced that bolus control and vallecular residue are changing from pre-treatment to post-treatment videofluoroscopy. One reason for the difference in our results may be that our patients are more heterogeneous in terms of underlying etiology than were those in the Robbins study.

Treatment

We have designed our tongue-pressure resistance treatment protocol based on that used by Robbins et al. (2005, 2007). Important elements of this design include blocked, repeated practice of tongue-pressure tasks; exercise loads that are likely to induce muscular fatigue; and a course of treatment that is about eight weeks long. We joke that this treatment is "boot camp for the tongue" because it really is like taking your tongue to the gym to push weights. In our treatment, patients practice about 60 tongue-presses in a 45–60 minute session. We measure their tongue pressures using a hand-held manometer [the Iowa Oral Performance Instrument (IOPI), invented by Erich Luschei]. This device, like other manometry devices, registers pressures that are generated when an air-filled bulb is compressed against the palate by the tongue.

A typical treatment session in our lab begins by registering the patient's MAXTPs for anterior and posterior tongue presses. For anterior presses, the bulb is held just behind the teeth and compressed with the front of the tongue. For posterior presses, the bulb is moved farther back and pressed with the back of the tongue. We measure each patient's MAXTP across a set of five repeated maximum isometric pressure tasks, allowing a 20-second rest in between presses. After we have established the MAXTP range for the day, we calculate amplitude targets to use in tongue-pressure practice. The Robbins group typically works with targets in the 60%–80% of maximum range. In our protocol, we are also interested in tongue-pressure accuracy, so our targets range from 25%–110% of MAXTP values.

Measuring Change

Measuring change in tongue-pressure capacity is quite simple. At the beginning of every session, we monitor the patient's MAXTP values for the anterior and posterior tongue across a series of five repeated tongue presses, as well as pressures on saliva swallows. These values typically climb over treatment. Figure 1 [PDF] shows examples of anterior MAXTP change across treatment in three different patients. The MAXTPs of the first patient (A) improved 169% compared to her session 1 values; patients B and C improved to 183% and 233% of their session 1 values, respectively. Notice, however, that the pace of change is different across these three patients. Patient A showed quite rapid improvement even in the first six sessions. Patient B was slightly slower to show improvement, but MAXTPs increased steadily across the first 12 sessions before reaching a plateau. Patient C showed a more gradual improvement, which continued all the way to session 24.

Treatment protocols may differ in whether or not pressures are measured during swallowing tasks. In our lab, we measure pressures during saliva swallows only. In some recent studies swallowing pressures have been measured with the IOPI during swallowing with different liquids (Youmans et al., 2009). Whether or not to test with liquids is a clinician's decision; some patients will have difficulty managing both the pressure bulb and a bolus in their mouths.

Risks

Tongue-pressure resistance training seems like a fairly safe intervention. However, it is important to remember that the treatment may change swallowing physiology in both beneficial and maladaptive ways. Therefore, it is very important to monitor functional outcomes with an instrumental swallowing assessment. We have recently conducted a small study using submental ultrasound to determine hyoid activity during tongue-pressure tasks (Sasse, Bressmann, & Steele, 2010). Our data show that hyoid excursion is very closely timed with tongue-pressure events during swallowing. We also have studied tongue-pressure tasks under videofluoroscopy in a small number of patients, and it appears that anterior MAXTPs engage hyoid elevation while posterior MAXTPs elicit anterior hyoid movement. We have observed a possible maladaptation in one patient who did tongue-pressure exercises; he achieved greater hyoid movement, but this was not accompanied by improved laryngeal elevation. As a consequence, we are now monitoring patients more closely for possible decoupling of the hyoid and larynx.

Additional Research

As interest grows in tongue-pressure resistance training, a number of research groups are starting to look more closely at the technique. Robbins' group is continuing to study tongue pressure in aging and in neurogenic dysphagia. They recently reported age-related differences in tongue fatigue during eating (Kays, Robbins, Hind, & Gangnon, 2010), a finding that will add an important consideration for the design and duration of treatment sessions. Lazarus and her group are studying tongue-pressure resistance training outcomes in patients with head and neck cancer, as is Allison Perry in Australia (White, Cotton, Hind, Robbins, & Perry, 2009). Studies of tongue-pressure capacity also are ongoing in children (Potter & Short, 2009). In our own lab, we are looking more closely at the timing aspects of tongue-pressure generation, in addition to strength considerations.

Clinicians can look forward to new research results in the next five years that will shape recommendations for implementing tongue-pressure resistance training into dysphagia rehabilitation protocols.

Catriona Steele, PhD, CCC-SLP, BRS-S, is an associate professor in the Speech-Language Pathology Department of the University of Toronto, a research scientist at Toronto Rehab. Her primary research interest focuses on the basic principles underlying clinical interventions for dysphagia and clinical outcomes following rehabilitative dysphagia treatment. Contact her at steele.catriona@torontorehab.on.ca.

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Systematic Review of Oral-motor Exercise

Systematic reviews use comprehensive and replicable methods to examine the state and quality of the scientific evidence on a specific clinical topic and can be an important time-saving tool for clinicians. ASHA's National Center for Evidence-based Practice in Communication Disorders (N-CEP) recently conducted a systematic review on the use of oral-motor exercises and sensory-motor interventions in adults with dysphagia. This review examined the outcomes of these interventions in four clinical areas:

swallowing physiology (e.g., swallowing pressures, aspiration, timing), pulmonary health (aspiration pneumonia), functional swallowing (e.g., oral feeding, weight gain, swallowing, quality of life), and drooling or secretion management. Of the 23 studies identified, the majority (18) were classified as early-stage exploratory research; the remainder were considered efficacy studies.

Mixed results for the use of these interventions were noted across the studies. This inconsistency could be due to the heterogeneity of study participants, interventions, or outcomes targeted in the included studies. Furthermore, many of the studies had significant methodological limitations. The review concluded that there is insufficient evidence to draw any conclusions on the value of these interventions in dysphagia treatment. Additionally, more well-designed controlled studies are needed to ascertain the effects of oral motor exercises and sensory-motor treatments on these important swallowing outcomes.

Scientific evidence is only one aspect of evidence-based practice. Clinician expertise and client values and preferences are other key factors that must be integrated into evidence-based clinical decision-making.

—— Tracy Schooling, MA, CCC-SLP
Associate Director
National Center for Evidence-Based Practice

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