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How Voice Exercises can assist in Orthodontic Treatment

Angela Caine AGSM LRAM
The Voice and Body Centre
436 Winchester Road
Southampton SO16 7DH, U.K.
www.voicetraining.co.uk

Summary

Orthodontists are constantly seeking answers to the following questions.

- How can I get my young patients to do exercises to improve soft tissue support during treatment?
- How can I achieve a natural tongue resting position in this patient?
- Will this treatment regress on removal of the appliances?

A new system of Voice and Body exercises has been developed at the *Voice and Body Centre* to re-programme the tongue and soft tissues during treatment and build strength and support to prevent regression after treatment. This treats the face and the tongue as one part of a whole muscle system to be exercised. They are *felt* to be effective by the patient in the improvement of speech and singing as soon as they are begun. They are also great fun and so they get done because people feel better for them and like to sing. The indirect result is success for the orthodontist.

Tongue thrust as a Dental Problem

"One of the many factors suspected of contributing to the tendency of teeth to return to their pretreatment position is tongue-thrust" (Andianopoulos & Hanson, 1987). Their's is one study in extensive literature devoted to the effectiveness or ineffectiveness of exercise therapy in the stability of corrected occlusion. In the case of this study the recommendation is quite clear. "These findings…indicate a need for serious consideration of the inclusion of a comprehensive course in orofacial behavioral disorders in orthodontic curricula"

All clinical and academic recommendations need to translate into a practical, user-friendly system if the busy clinician is to apply them to the patient successfully. What works in a study, where it is administered and controlled by a number of technicians and regularly enforced, does not necessarily pass the test in the public arena, through lack of time and attention. The activities available for correcting tongue posture are the activities it affects through their related muscle systems:

- Nose breathing (Mew, 1979);
- Swallow (Garliner, 1974; Mew, 1979);
- Jaw position (Mew 1979; Garliner 1974);
- Speech (Caine, 1998);
- Singing (Caine1998);
- Chewing (Caine 1995);
- Upright posture (Rocabado et al. 1983).

Two of these - 'singing' and 'upright posture' - have not yet been considered as part of the "orofacial behavioral disorder" syndrome and do not form part of any 'comprehensive course'. The developmental shifts in the hyoid/occiput/TMJ triangle (Bibby and Preston, 1981) throughout the years leading to mixed dentition at approximately 6 years old have similarly not been considered by orthodontists, although it is recognized in the orthodontic literature that there is a period when 'maturation of swallowing pattern 'occurs' (Ackerman and Klapper, 1981). This leads to the hypothesis that a much simpler and more efficient orofacial behavioral correction would be possible by examining the way that all of these systems interact and designing an exercise programme in which systems were encouraged to support each other.

Chewing requires that the tongue falls into the floor of the mouth and acts in a forward and down position in relation to the mandible to maintain food between the teeth. When the tongue loses the 'up and back' resting and functional position for nose breathing, swallowing, speech and singing and is forward and down for *all* function, then it must be corrected for all of these functions if it is to maintain stability in any of them.

If the front door is locked, it seems sensible to wander around the building and see whether there are any back doors that will open more easily. You may come then come to the front door from the inside and the key may be there, waiting to be turned.

Forward Tongue Position as it relates to Voice

Figure 1 shows a picture of Sam who is not, and never has been, an orthodontic patient. She came to me with a burning desire to sing and be a pop star. She brought a CD backing track and delivered a song from the charts. She had the following problems:

- beyond a pitch range of about six notes she sang out of tune;
- her words were indistinct;
- she had forward tongue posture, forward head posture, and forward shoulder posture.
- She has a beanbag on her head to bring her head into line, but it does not alter her face muscles and tongue.

Figure 2 shows Sam approximately three months later, during which time she was given a voice and body exercise programme to correct the above problems. It also improved her singing so much that she was accepted into the school choir and a drama group and she could sing to all her backing tracks. If you are wondering how two pictures three months apart have the same jumper, this is Sam's school uniform.

I used speech and singing to re-programme her tongue and face muscles, knowing that a face and tongue with this muscle pattern has an unnaturally high hyoid bone. A high hyoid is concomitant with hypertonic supra hyoid suspension (Rocabado *et al*., 1983) and that

Figure 1 Picture of Sam before voice and body exercises

Figure 2 Picture of Sam after voice and body exercises

this has an adverse effect on the voice. The person with a tongue in a forward resting position has a breathy, pale, voice lacking in lower harmonics. For some years I have been routinely correcting tongue position in singers in order to correct hyoid bone position, add lower harmonics to the voice and improve singing ability. The muscle pattern in Sam's face suggested a tongue and hyoid problem and it was confirmed by the sound of her voice.

This problem is not exclusive to children. The faces in Figures 3 to 5 are of people who have joined the Voice and Body Centre to correct voice problems. In all 3 cases the voice problems were found to be caused by an unnaturally high hyoid and hypertonic supra hyoid suspension. They have forward tongue posture.

Forward tongue position in singers - is voice training to blame?

I discovered by trial and error that trying to move the tongue away from the teeth by creating an awareness of the front of the tongue and reposition it further back did not work. When the client tried to work with the front of the tongue it was always accompanied by the lengthening of the face, the narrowing of the nostrils and tension around the mouth were intensified. 'Trying' to do something with your tongue is attempting to organize a mixture of voluntary and involuntary muscle with a voluntary action. It is not possible without a co-ordination of right and left-brain. 'Trying' only accesses left brain activity.

(Springer & Deutsch, 1998).

Figure 3 shows a singing teacher, aged twenty-six. She had premolar extraction in her early teens and no muscle tissue preprogramming. She has a narrow maxilla and articulates speech sounds against the anterior teeth with a forward tongue. Her voice is lacking lower harmonics. Her belief system for clear articulation concentrates effort and exercise on the tip of the tongue against the teeth. This has resulted in a hypertonic masseter muscle (Caine, 1998), as can clearly be seen.

Figure 4 shows a dancer, aged seventeen. While standing passively (left) she appears to have an attractive open face with a balanced muscle system. This is surely not a tongue thrust patient. When we turn her sideways (right), and ask her to sing, the whole body balance changes and a forward thrust pattern occurs. There is a forward shift at the ankles, which places excess weight on the front of the feet, and this affects hips, shoulders, and head. This is the domino effect when the body loses balance in the presence of forward tongue posture. Bear in mind that this is a dancer aiming for a professional career.

She had premolar extraction in early teens with no exercise programme to maintain tongue position. She has a narrow and restrictive maxilla. She has also exercised the tip of the tongue against the teeth, believing it will improve articulation, a common singing technique in the UK. The singing teacher was also trained in the UK, where singing teachers are not required to study functional anatomy.

Figure 3 Singing teacher with voice problems

Figure 5 shows a music student, aged eighteen. He had premolar extractions at age 12 and fixed appliances for the following 18 months, with no muscle reprogramming. Note the similarities to Figure 3 in facial muscle balance. He had hypertonic masseter, a narrow maxilla and forward tongue posture. He could not sing and wished to regain, if possible, the voice that showed considerable

promise at age 15, when he was selected as a principal singer for National Youth Music Theatre UK. By seventeen years old he was beginning to have jaw pain ("Couldn't open my mouth far enough to sing").

Figure 4 Dancer not singing (left) and singing (right)

At fifteen he also began to have problems with skiing and tennis, competitive sporting activities in which he had shown early prowess. The University noted all the problems and sent him to a consultant laryngologist, who could find nothing wrong with his voice, but advised complete rest. A consultant orthodontist found nothing wrong with his jaw, but noted that many students suffer from tight jaws because of emotional stress. He now studied the double bass but he wanted to sing. Was there any possible action? He was fitted with appliances to widen the palate and at the same time exercises were given to:

- reposition the tongue, which now rested in the floor of the mouth, there being insufficient width for it to rest against then palate. (It is important to begin the tongue exercises with the fitting of the appliance, or even before it);
- increase the priority for nose breathing by increasing the work of lateral face muscles and reducing the hypertension in masseter (which can be seen in Figure 5);
- re-programme speech for vowel priority and rhythm.

His lack of balance was diagnosed as a Category II misalignment by a cranial chiropractor.

All of the exercises were designed to use the voice, body and left and right brain. Physical improvement was monitored by the improvement, ease and gain in confidence in his singing. As the palate widened and the suprahyoid muscles released, the voice gradually gained strength. Extended pitch became possible with the introduction of build-ups on the back molars. This was an experiment on this tenor but

Figure 5 Music student with a voice problem.

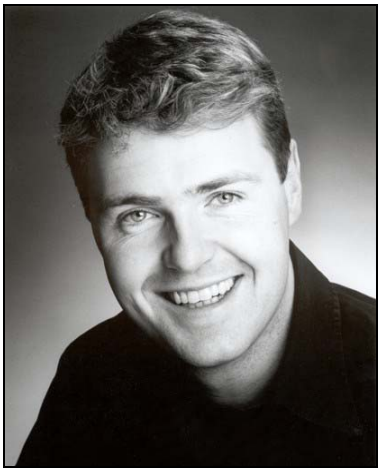

Figure 6 The final result, six years from the beginning of treatment, after reverse orthodontics to replace premolars, chiropractic support and voice and body exercises

substantiated by Fonder (1976) where cases were documented of head/neck, tension being relieved by increasing the vertical molar support. Fonder had not extended his work to include singers, but in all our experiments with buildups in relation to voice quality we have been able to extend the range and harmonic profile of the voice with increased vertical in molar support.

It took another two years for this singer to develop the space in the palate that was lost by premolar extraction. When that was accomplished the resulting spaces were bridged and now, four years after completion of treatment, crowns are to be fitted to maintain permanently the vertical dimension that produced the tenor range. It is now six years since the beginning of treatment and there is no regression (Figure 6).

The Broader Implications of Tongue Thrust

The head/neck is a major area of development, growth and modification, during infancy, childhood and adolescence. The tongue is central to, and a major influence on, that growth, change and development. It is also a major factor in the efficiency and maintenance of those systems in adult life.

The tongue, in co-ordination with the three pharyngeal constrictors is the main articulator of vowels, the fundamental formant of which is produced in the larynx. The larynx is suspended from the hyoid, which is the attachment for the base of the tongue. Upwards and forwards thrust of the tongue is the main factor in unnaturally high position of the hyoid. This limits the function of the larynx in both breathing and vocalizing. To see tongue-thrust as a dental problem is to see the tip of the iceberg.

Tongue position in the infant

The role of the tongue in the infant is to suck. To facilitate this action all of the tongue lies in the oral cavity (Figure 7). Babies are unable to breathe through the mouth, except by screaming, which pulls the larynx down and breaks the seal between soft palate and epiglottis, made possible by the high larynx. (Crelin, 1973) Mouth breathing is acquired as a supplementary 'top-up' system in co-ordination with the descent of the hyoid/laryngeal complex. Mouth breathing should remain a 'top-up' system throughout life, catering for moments when sudden extra energy is required. At such times the tongue pulls away from its natural resting position to allow air through the tongue/soft palate seal at the back of the mouth, but this must only be a supplement. Long term, mouth breathing will initiate changes in the facial muscle system and cause dental stress.

Early Tongue Connections: Articulation, Posture, Dentition

From birth to about two years old, the infant is learning how to be upright on two feet and developing the muscle strength to cope with that. The stages of rolling and crawling develop cross patterns of the muscles in arms and legs: this gives the body its rotation possibilities (Dart, 1968). From approximately two to six years old the toddler experiments with balancing and this selects specific muscle patterns for control of upright posture in standing, sitting, running, etc. First teeth are

Figure 7 Right half of the head of a male infant cut in the mid-saggital plane (after Crelin, 1987)

appearing during this period of change from infant to toddler in a palate already rhythmically massaged into continuous widening by the tongue and by the development of speech and singing.

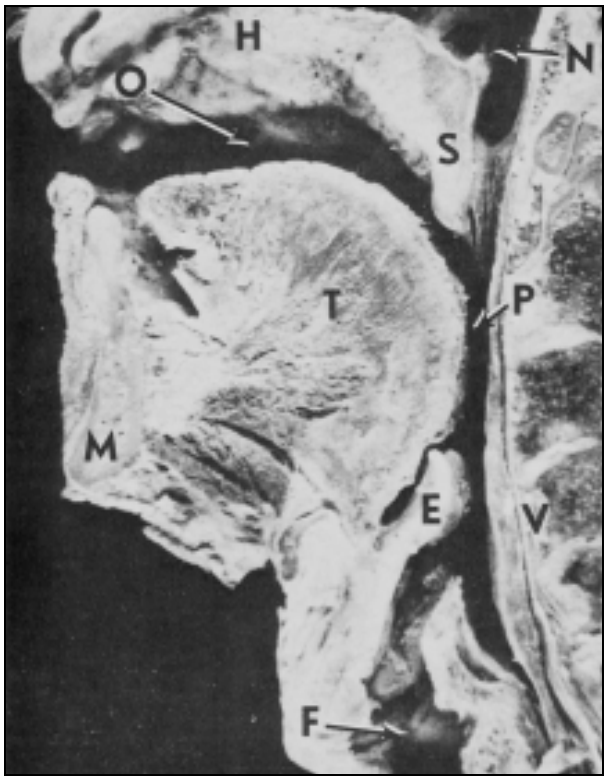

Figure 8 Right half of the head of an adult male cut in the mid-saggital plane (after Crelin, 1987)

During the period of toddling and balancing, the Hyoid will descend to a position approximately half way down the second constrictor, thus re-positioning the attached base the tongue. The tongue is now two-thirds in the Pharynx and one-third in the oral cavity. This facilitates the articulation of both vowels, in the Pharynx, and consonants, in the oral cavity. This period of shift for the larynx and tongue is completed between the ages of 5 and 6 years old (Crelin, 1987). Tongue, Hyoid and Larynx are now in the adult position (Figure 8), ready for the change to mixed dentition, which also begins at approximately 6 years (Hiatt & Gartner, 1987). Goddard (2002) suggests that there is a moment in the learning-to-read process at which the balance in the brain tips from right to left, at approximately 6 - 7 years of age. Upright, balanced and co-ordinated posture, and its central nervous system (CNS) control, matures between 6 and 8 years (Goddard, 2002). It is reasonable to assume that this is not coincidental, but that development of the child's CNS, voice, posture and dentition are interdependent.

Note the difference in the angle and position of the mandible between Figure 7 and Figure 8. This has occurred with the descent of the Larynx. Lack of full development of vocal mechanics at 6 years old can be an early indication of impending dental problems.

Role of the tongue in early development

The role of the tongue in early development is:

- central to breast feeding, nose and mouth breathing, swallowing, development of the facial bones and development of the nasopharynx;
- a determining factor in the shift of the larynx from the infant position, where the epiglottis can lock into the soft palate, to the adult position where the larynx lies between the 6th and 7th vertebrae (Crelin, 1973);
- to support and maintain the development of language skills during the transition period between approximately 1 year and 6 years of age, when shifting vocal and articulatory mechanics can interfere with articulate speech;
- the main articulator in adult speech and singing (after 6 years old). Its efficiency affects all communication skills and therefore, to a great extent, personal confidence (Caine, 1995);
- to determine the position of the mandible (Garliner, 1974);
- to contribute to postural balance and coordination (Rocabado *et al.*, 1983);
- to help to develop Maxilliary space for the teeth..

The Hyoid suspension inserts into the styloid process of the Cranium. The Hyoid is stabilized inferiorally by the Omohyoid muscle inserting into the shoulder blade. Thus a chain of postural integrity is maintained from cranium to shoulder girdle via the vocal suspension and then linked to pelvic stability via Serratus Anterior and the transverse abdominal muscle system (Figure 9).

Possible causes of Forward Tongue Posture not generally considered in orthodontics

Lack of development of the craniofacial complex through birth trauma.

The tongue does not fit into a maxilla with a high Gothic arch. This breaks the rhythmic muscular co-ordination between tongue and soft palate. The tongue loses its upper reference. This weakens both styloglossus and tensor palatine, which would normally co-ordinate to move the main tongue weight into the pharynx, where gravity would influence its downward shift with every step. The rhythm of a running, skipping child, with a strong styloglossus and tensor palatine muscle acting in speech and singing pumps the Eustachian tubes and maintains efficiency. This suggests a possibility of glue ear in the child with weakness in these muscles.

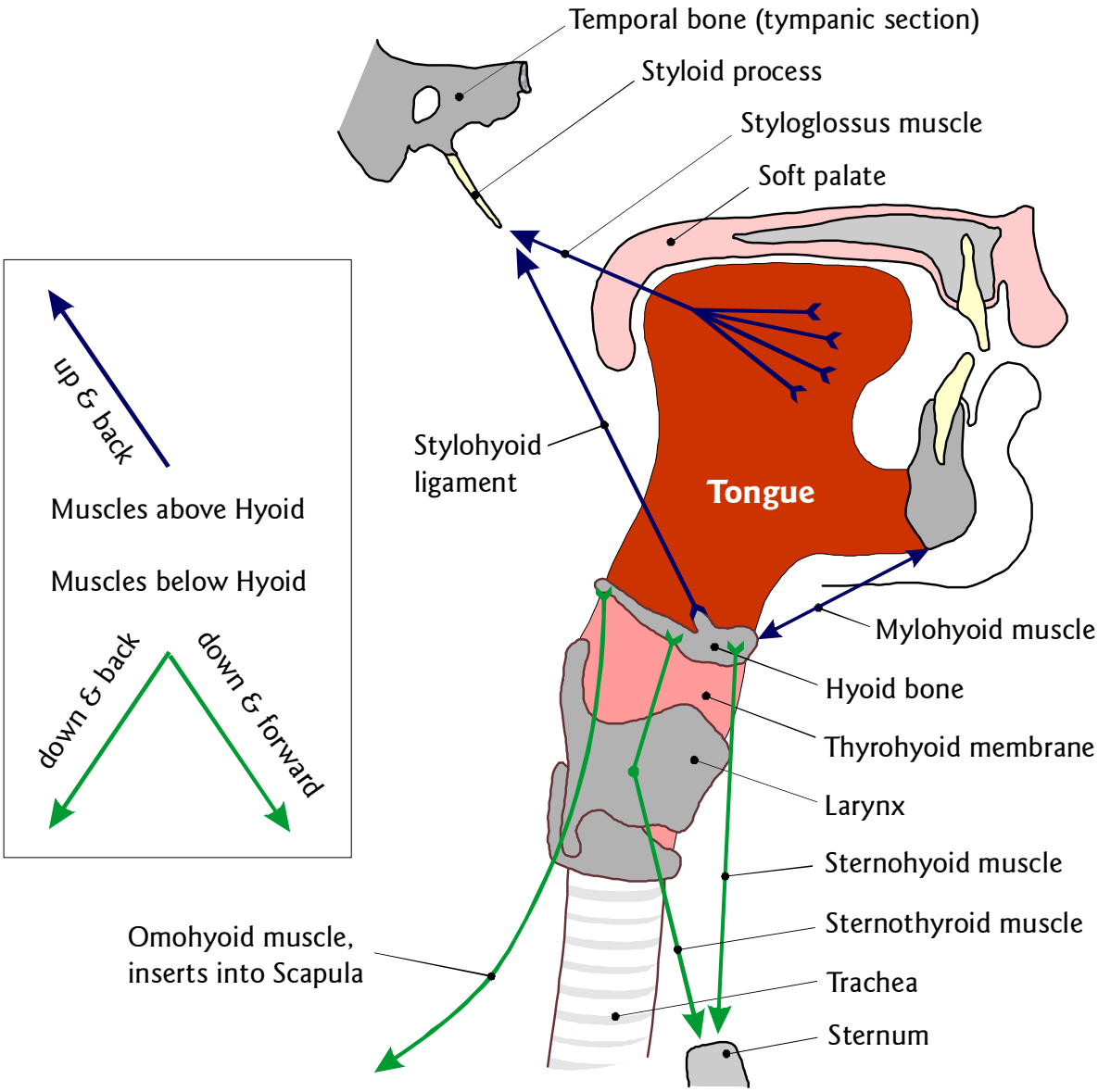

Figure 9 Support for the tongue provided by the extrinsic muscle system

Lack of exercise

Self righting reflexes, the postural muscle support system, body strength, right and left centres of the brain, all must be stimulated if the child is to develop, at 6 years, the low, adult position of the larynx.

Ignorance of vocal mechanics when teaching children to read

The cobra-like action of a tongue in a natural resting position with the main weight forming the anterior wall of the throat is only stable in the final stage of laryngeal development at six years old (Crelin, 1987). Before this, articulation is constantly changing. Phrases that are easy to say at four could become difficult to say at five because the tongue has a different reference. If parents and teachers exert pressure on correctness of speech and do not allow for learning to be fun, this may prevent the completion of the movement of the tongue shifting downwards and backwards to its naturally low position (Caine, 1998).

Balanced facial development

The face muscles can be divided into two groups.

Group 1 Muscles

Group 1 muscles (Figure 10) are concerned with nose breathing, swallowing, speech, singing and all the facial expressions of happiness, confidence and spontaneity. They radiate from the centre of the face. They originate in bone and insert into moveable tissue.

The action of Group1muscles encourages the cranium to widen in the facial area and flare the nostrils. This reduces pressure throughout the nasal cavities and maxillary sinuses, and as a result the outside air moves into the nasal sinuses. The air can then be warmed, cleaned and sterilised before the contraction of the diaphragm and opening of the glottis of the larynx pulls air from the dead space of the pharynx into the lungs. Imagination and emotion can extend this action into a smile; further still into laughter. These muscles stretch the skin of the face in an upward and outwards direction, thus widening the whole facial aspect. This is following the model of beauty that is so universally accepted. The efficiency of this muscle action is dependant on the resting position of the tongue being in the palate.

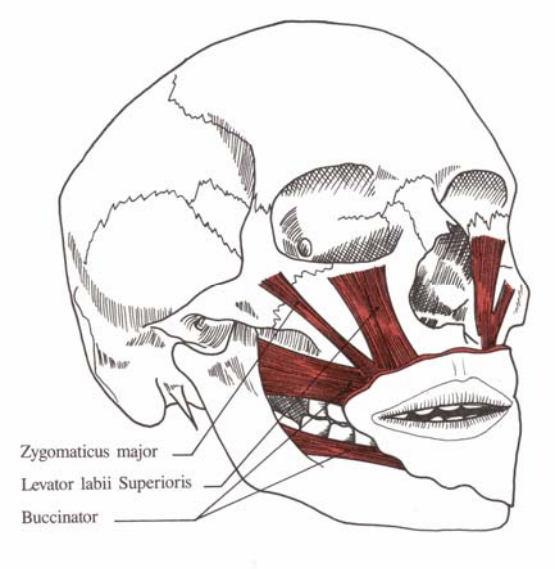

Figure 10 Group 1 face muscles

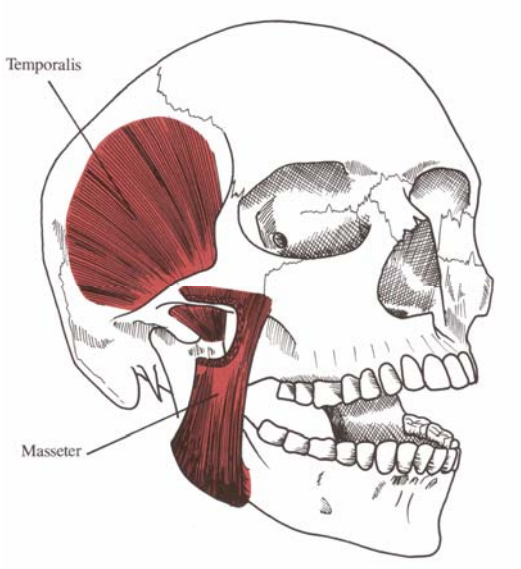

Figure 11 Group 2 face muscles

Group 2 Muscles

The group 2 muscles (Figure 11) act in the vertical plane to chew. For strength and purchase they originate in bone and insert into bone, and they have more bulk and less delicacy than Group 1.

The Temporalis muscles snap the teeth together and masseter applies a vertical force to crush food against the molar facets (aided by lateral movement from the Pterygoid muscles, not shown). These muscles generally have no function in breathing, speech, singing, or swallowing apart from a few anterior fibres of the Temporalis muscle that suspend the mandible in a position to facilitate independent action of the tongue in articulation of speech

Group 2 Muscles are activated when the tongue takes up a forward and down position to push food between the teeth and the lips are firmly closed to keep the food in. The mouth must be closed to chew, but closing is not necessary for nose breathing.

When tongue action is efficiently balanced, and the tongue suspended at the back of the mouth, it is the seal between tongue and soft palate that determines whether you breathe through the nose. Pressing the lips together and vacuuming in air through the nose merely interferes with facial muscle balance and narrows the nostrils. Scowling and sulking and other expressions associated with unhappiness are involuntary expressions of Group 2 muscles (Caine, 1995).

The right brain in muscle reprogramming

It is important for reprogramming any muscle systems to know which muscles are voluntary and which involuntary. The intrinsic muscles of the tongue are involuntary. In speech they make vowels by shaping the main mass of the tongue and changes to this musculature can only be made through the ear and imagination, using the creative right brain.

The extrinsic tongue musculature is voluntary. So although you cannot directly control the sounding of the vowels, you can shift the whole tongue to a different position with the extrinsic muscles, which are controllable. By learning to control these musclesyou can determine which part of the space between the dental arches and the larynx the intrinsic tongue muscles make that vowel shape. Ideally it is as low down the pharynx as possible, and should include the third constrictor. This effectively keeps the action of speech off the teeth and the tongue articulates consonants against the hard palate. Main tongue weight remains in the pharynx. The tongue is now using gravity in the deeper excursion of the larynx at every in breath. As the hyoid moves down, the tongue is pulled backwards. Aided by the controllable action of styloglossus, the front third of the tongue, which lies in the oral cavity, is raised and makes a seal with the soft palate to prevent unnecessary mouth breathing. It is important to note that this action is not in any way dependant on the mouth being closed. Muscles that open and close the jaw are not prime movers in the articulation of speech, but act in response to the movement of the tongue and hyoid.

Figure 12 The toothbrush poem, to stretch jaw ligaments and build Anterior Temporalis

The Voice and Body Exercise Programme

Figures 12 - 14 show examples of the exercises that have been developed at the Voice and Body Centre. The success of this exercise programme is in the use of the voice and the role of the tongue as an articulator for speech and singing. All previous treatment of tongue thrust has begun at the tip of the tongue and attempted to move the third of the

tongue lying in the oral cavity away from the dental arches.

The voice and body exercise programme begins exercising the whole body and stabilizes the hyoid in its adult position through strengthening the connection between shoulder blade and hyoid (Omohyoid). The extrinsic tongue muscles are then rebalanced and strengthened for natural tongue resting posture against the back of the palate by changing learned speech and singing patterns. The client is encouraged to work for the improvement of the voice, communication skills, singing and personal development.

There are numerous references in the literature of orthodontics to the importance of the full broad smile and improved self image possible through appropriate treatment. It is not so easy for the general public, especially the children to understand that the mouth full of metal and the painful catching of sensitive tissue will change their lives for the better and give them these personal advantages. There is an immediate 'feel–good' factor in the buzz you get from singing, or moving your body rhythmically and this can begin when the appliances are fitted. The programme begins the day you have a dental assessment. From the onset of treatment you are involved in, and share responsibility for, its success.

Figure 13 Returning to primitive reflex patterns

The programme design is based on revisiting crucial early developmental changes in head/neck soft tissue: these changes may have been delayed by birth trauma or may be undeveloped through lack of exercise, encouragement, or parental ignorance of what is needed for that development.

The Tongue Exercise Programme is designed to:

- improve vocal efficiency, articulation and rhythm by completing the laryngeal shift;
- re-programme facial muscles to support natural tongue resting position;
- stimulate postural self-righting reflexes to balance possible misalignment of the laryngeal suspension;
- exercise and stabilize the shoulder girdle and pelvis and make a direct muscular connection from this stability to the tongue via the omohyoid and other postural supporting muscles.

Figure 14 Upside down reading, to exercise Infra Hyoid muscles

Figure 14 Stretching and bouncing while reading aloud, to reposition the tongue

Tools

A physio ball, a stretch band, a bean bag, a balance board, a toothbrush, and an audio CD are all used as tools to re-programme muscles and revisit learned reflex patterns. Like the orthodontic appliances these tools go home with the client to be used regularly between sessions with a teacher (in small children this can be a parent}. The tools provide a valuable reference for doing the exercises correctly, stimulating muscle systems and questioning present vocal patterns. Efficiency, balance and structural alignment are the fundamentals of the programme. An important aspect of the exercise system is the inclusion of right brain activity - imagination and creativity.

Play is a natural ingredient of learning anything. All the voice and body exercises used for this exercise programme have been designed for fun and enjoyment as well as efficiency. A brain that is bored is not registering anything.

Conclusions

Orthodontic treatment reduces dental distress and improves self-image. Techniques are advancing rapidly and appliances are increasingly preventative. Dentists, chiropractors, osteopaths and cranial therapists are now working together to integrate treatment protocol so that the whole person can be balanced upright on two feet with the minimum effort and maximum energy for enjoying life. A fundamental role of muscle is to position bone and in all the literature on development and improvement of treatment, two areas are constantly discussed as being problematic:

- muscle re-education in the face of skeletal change (the teeth being included here as they are jointed with the skeleton);
- the apparent inability of the patient to carry out exercises that would bring muscles into line with the changes.

Experience of running exercise systems is that no one does exercises that are ineffectual and that are not fun. There is no evidence that current maxillofacial exercises are effectual and they are certainly not fun!

A new system of voice and body exercises has been developed at the Voice and Body Centre. This treats the face and the tongue as one part of a whole muscle system to be exercised. They are *felt* to be effective by the patient in the improvement of speech and singing as soon as they

are begun. They are also great fun and so they get done because people feel better for them and like to sing. The indirect result is success for the orthodontist.

Speech has for homo sapiens during the last 50,000 years, superseded chewing. Simpson (1968) states "Language has become far more than a means of communication in man. It is also one of the principal means of thought, memory, introspection, problem solving and other mental activities". Crelin (1987) states that "Ultimately, articulate speech led to a complicated spoken and written language, abstract thought, the fifth symphony and the theory of relativity".

If a system so powerful exists within the musculo-skeletal system, it seems sensible to access that power in corrective treatment. We must come to accept that the mandible is undergoing a change in function. It is no longer designed for chewing, but to support the system of sophisticated, articulated speech. We must use that development.

For more details of the VoiceGym exercise programme to reposition the tongue and re-programme soft tissue during orthodontic treatment see www.voicetraining.co.uk.

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