

Speech and voice rehabilitation in selected patients fitted with a bone anchored hearing aid (BAHA)

JULIE THOMAS, M.R.C.S.L.T.

Abstract

Within the Birmingham osseointegrated implant programme there have been several patients with severe pre-lingual conductive hearing loss. The majority of these have been patients with Treacher Collins syndrome.

There are characteristic features of speech and voice in those with long-standing conductive hearing loss. In addition, the associated abnormalities of jaw, teeth and palate may amplify the problem. There may be spontaneous improvement in features such as voice pitch, quality and intensity following the fitting of a BAHA. However, in those with a pre-lingual hearing impairment, speech therapy may be necessary. Patients assessed as suitable for BAHA have a full assessment of communication skills including audio recording of speech and voice. Post-operative training improves auditory discrimination and perception and is followed by training in the production of the newly perceived speech sounds.

Key words: Hearing aids, bone anchored; Rehabilitation, speech and language

Introduction

The Birmingham osseointegrated implant programme has a multi-disciplinary team approach. The team consists of an otolaryngologist, a maxillofacial surgeon, audiologists, maxillofacial prosthetists/anaplastologists, nurses, and a speech therapist.

Of the first 41 adults fitted with a BAHA, 20 had a pre-lingual moderate to severe conductive loss. A speech therapist was added to the team partly because of the speech and/or voice problems evident in this group which persisted following the fitting of bone anchored aids. In 10 of this group, hearing impairment was due to atretic ears, thalidomide embryopathy or suppurative otitis media from a very early age. The other 10 were people with Treacher Collins syndrome.

There are characteristic features of speech and voice to be found in people with a pre-lingual, moderate to severe conductive hearing loss. The possible effects on voice are a higher than average pitch for age and sex; a restricted pitch range; reduced or abnormal intonation patterns; reduced intensity (Metz *et al.*, 1990).

The effects on speech reception and expression vary depending partly on the degree of deafness, the age of onset of deafness, and the age when first aided.

Possible effects on speech reception are a lack of awareness of high frequency sounds, poor discrimi-

nation between high frequency sounds, poor auditory feedback/self monitoring.

In a young child learning to talk, even a mild conductive loss can affect perception of high frequency sounds. These sounds are produced by a constriction at some point in the vocal tract as air is being exhaled. This produces audible turbulence and can occur at many points to produce sounds which are distinctive but very similar to someone with a hearing impairment – if indeed they are perceived at all. Different fricative sounds occur in different languages. Figure 1 shows the points of articulation for the consonants of English. If perception of sounds is poor then development of a normal phonology i.e. a sound system for a particular language, is likely to be difficult. The phonology of any language is largely a system of sound contrasts which alter meaning. For example:

English:	she	sea	tea
Italian:	chi	ci	so
German:	zain	schein	kein
Swedish:	kött	skött	sött

If discrimination between /s/, /sh/, /ch/ and /t/ is difficult, one sound such as /t/ may be used for all fricative sounds i.e. 'sea', 'she' and 'tea' would sound the same. Alternatively, all fricative sounds may be omitted or the visual pattern alone may be used e.g. the spread lip pattern for /s/ may be used but with no accompanying sound. Intelligibility may be greatly

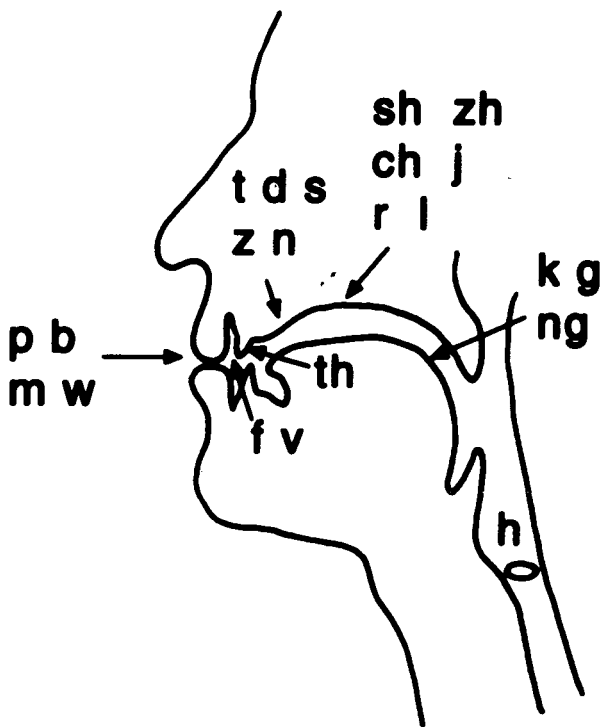


FIG. 1

Points of articulation for the consonants of English.

reduced making articulation difficult, stressful and possibly embarrassing. An example of this type of patient is the man who was the first patient to receive a bone anchored aid in Birmingham at the age of 31 years. He reports that his parents first suspected a hearing problem when he was about 18 months old following frequent ear infections and then he did not start to talk until he was five years old. A body-worn aid was fitted at that time but he states he 'couldn't adapt to it'. A behind the ear aid was fitted when he was six to seven years old and he wore aids continuously from that time. This man admits to being very self-conscious about his speech and also about the effects on his education that early hearing impairment and the resulting poor speech and language development have had. He is a very intelligent man and highly motivated to improve his speech. It is four years since he received his BAHA and improved hearing had made him aware that his speech is different from that of others. Some high frequency fricatives are affected i.e. /s/ is palatalized and /th/ is replaced with /f/. His speech is easily intelligible but draws attention to itself and is therefore a source of embarrassment to this patient. His improved hearing following the fitting of the BAHA has facilitated his ability to respond to speech therapy.

For people with Treacher Collins syndrome, it is even more difficult to develop normal articulatory patterns as, in addition to a degree of pre-lingual conductive hearing loss, there are a number of other possible conditions which can alter speech. There may be: retracted mandible, restricted jaw movements, oropharyngeal crowding, maloccluded teeth, high/weak/cleft palate or a tracheostomy at the time

speech should be developing (Massengill *et al.*, 1971).

Figure 2 shows the typical profile of a person with Treacher Collins syndrome. With the disharmony between maxilla and mandible, production of sounds normally made by articulations of the tongue tip behind the top teeth such as t/d, s/z, ch/j are much more difficult. The normal sized tongue is bunched up in a restricted oropharyngeal cavity. Partly due to this and partly due to impaired hearing in early childhood, these people are likely to have developed compensatory articulations with the middle and/or the back of the tongue e.g. /s/ would be replaced by palatal or velar fricatives.

If there is weakness or cleft of palate, there may be a nasal quality to the voice. Consonants may be weak or may be accompanied by audible nasal escape. The nasality may be masked by a very muffled voice quality which is the result of the tongue crowding the oropharyngeal cavity. If extensive jaw surgery is performed after speech has developed, one result may be that the velopharyngeal incompetence becomes more apparent (Meyerson and Nisbett, 1987).

The Birmingham team has only recently begun to look at the speech and voice of adults with Treacher Collins syndrome but the ten people with this syndrome who have been fitted with BAHAs all

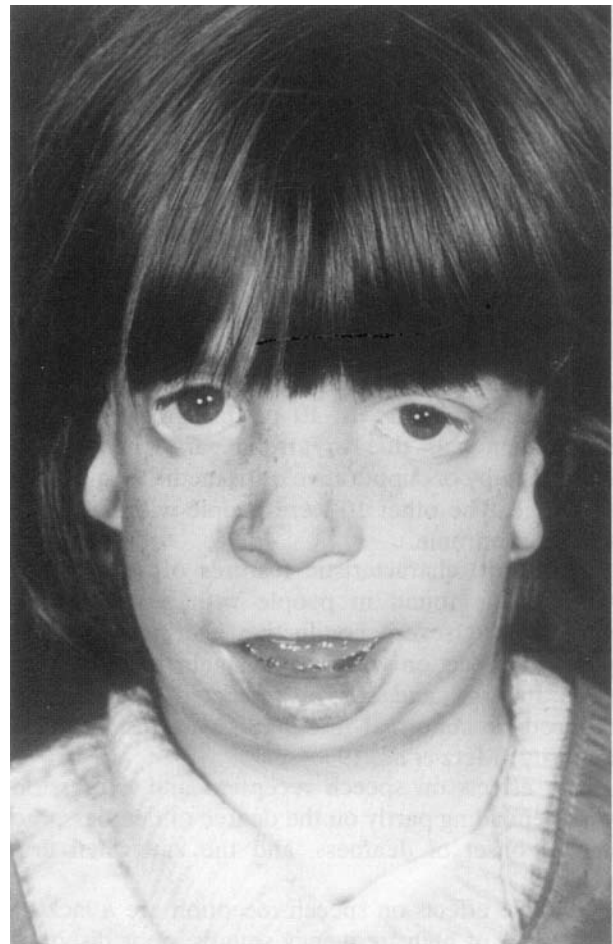


FIG. 2

Typical profile of a person with Treacher Collins syndrome.



FIG. 3

D. aged 16 years before jaw surgery.

exhibit to differing degrees some or all of the outlined characteristics. The severity varies according to the degree of deafness, the degree of disharmony between the mandible and the maxilla and the degree of velopharyngeal incompetence.

An example of this type of patient is a lady with a severe form of the syndrome with whom we have worked. This lady, who is pictured in Figure 2, aged eight years, was born in 1960 with gross disproportion between the upper and lower jaws, an anterior open bite, a bilateral 60 dB conductive hearing loss but good cochlear function, remnants of pinnae, deformity of the lower eye lids and cheeks and a narrow airway.

She was fitted with a bone conduction aid at the age of three years. She describes that aid as 'horrible' but says that she put up with it because 'once you hear sounds you want to go on hearing them'. At the age of 16 years she underwent surgery as a result of which she was able to occlude her teeth, maintain lip closure and chew normally for the first time in her life (Figures 3 and 4).

At the age of 30 years this lady was referred to the Birmingham team suffering from depression and low self esteem. In 1991 she was fitted with a BAHA and prosthetic ears (Figure 5). The BAHA brought her hearing levels up to those of a mild loss and, following fitting of the aids, her habitual voice pitch lowered spontaneously and she used an extended

pitch range to good effect. Her articulation however, remained unchanged. Her speech still drew unwelcome attention to her and rendered her unintelligible at times, particularly on the telephone.

On the Birmingham programme, patients with long-standing severe, conductive loss undergo a full assessment of speech and voice before being fitted with the BAHA. The R.N.I.D. speech assessment procedure is used (Parker, 1983). Audio recordings are made of:

- (1) serial speech e.g. 1–10 days of the week, to set recording levels and check whether the characteristic intonation pattern is used;
- (2) a test of intonation and stress;
- (3) a full assessment of phonology;
- (4) two reading passages;
- (5) one to assess intonation, rhythm and stress;
- (6) one to assess voice pitch, pitch range and voice quality;
- (7) a sample of conversation.

We hope to include nasendoscopy and video-fluoroscopy to assess velopharyngeal competence in the near future before and after surgery and/or speech therapy.

Another set of recordings is made following fitting of the aid when hearing may have improved enough to allow a person to hear high frequency sounds



FIG. 4

D. aged 16 years after jaw surgery.



FIG. 5

D. with BAHA and ear prostheses.

relatively normally, possibly for the first time in his/her life. Voice pitch, pitch range, quality and intensity often improve spontaneously following adjustment to the aid and to the new levels of hearing (Cowie and Douglas Cowie, 1983). Histograms printed out after computer analysis of the reading passage show the sound frequency in Hz along the horizontal axis and how often a frequency is registered on the vertical axis. The histograms in Figure 6 are those obtained from recordings of a young lady 17 years of age before and after she was fitted with the bone anchored aid. The solid line shows the relatively high habitual pitch and narrow pitch range used before aiding. The broken line shows the slightly lower pitch and increased pitch range achieved spontaneously following fitting of the aid which will allow for improvement in intonation following training. This lady has a milder form of Treacher Collins syndrome than the other lady mentioned but had a more severe hearing loss. Her articulation is more easily intelligible but intonation, rhythm and stress are more affected.

Even following dramatic improvement in hearing, articulation patterns are unlikely to change without intervention (Metz *et al.*, 1990). A life-long system is deeply rooted as anyone who has tried to learn a foreign language in adult life will agree. This is in effect what these people, who are hearing their own

language clearly for the first time, are attempting to do. Also, people with Treacher Collins syndrome may have undergone jaw and/or palate surgery at some stage and need to adjust to the new physical relationships between the jaws, tongue, teeth and palate as well as to the new levels of hearing.

Those who are motivated to improve their speech are offered a course of speech therapy following fitting of the aid. The most important part in treatment is the training in auditory discrimination and perception of sounds which are either new to the patient or have been confused in the past. Once a person is able to perceive the difference between their speech and that of others he/she can be taught to produce the new sounds him/herself. Once production of isolated sounds is achieved, training is needed in using the sounds in words, sentences and reading and finally in spontaneous connected speech. These people need to unlearn one sound system and replace it with a new one.

The lady with a severe form of the Treacher Collins syndrome already discussed was highly motivated to improve her speech. Therapy began one month after fitting of the BAHA and, within five months, she had learnt to speak clearly and intelligibly even on the telephone. From using a very restricted system of ten consonants, some of which were non-English sounds, instead of the normal 25 consonants of English, she is now using at least close approximations of all 25. From being depressed and lacking in self esteem, this lady is now very positive and confident as a result of the multi-disciplinary intervention of the Birmingham team.

Other assessments and outcome measures are being investigated including further assessment of any palatal defect and objective measures of improvement in both segmental and suprasegmental characteristics of speech. The possibility of scaling the degree of impairment, disability and handicap before and after fitting of a BAHA, surgery and/or speech therapy will also be considered (Enderby, 1982).

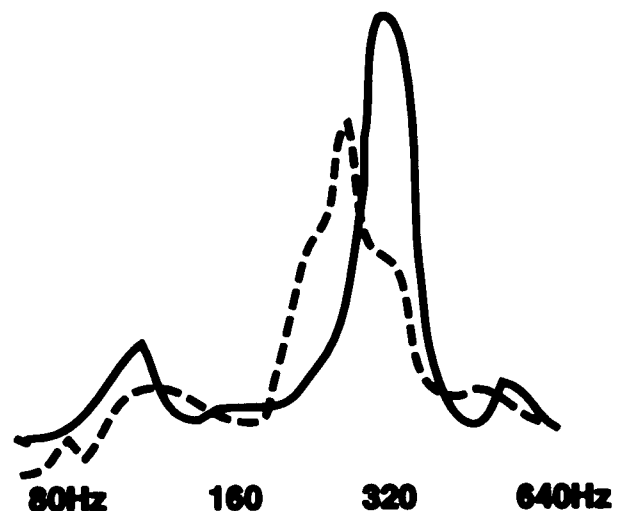


FIG. 6

Pitch histogram.

This paper has been concerned with adults. It is to be hoped that today children with pre-lingual conductive loss and conditions such as Treacher Collins syndrome have earlier diagnosis of hearing impairment, earlier appropriate aiding, and supervision by a speech therapist from an early age to provide, when necessary, auditory training, assessment of velopharyngeal competence and help in developing normal compensatory articulations.

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