Tooth position and speech—is there a relationship?

Nicola C. L. Johnson, BDS, FDS RCS; Jonathan R. Sandy, PhD, FDS, MOrth RCS

Abstract: Although it is widely accepted that teeth play an important role in speech production, the relationship between tooth position and speech remains controversial. This review paper examines the relevant studies and discusses the difficulties of scientific investigation in this area. The ability of patients to adapt their speech to compensate for abnormal tooth position is recognized, but the mechanisms for this adaptation remain incompletely understood. The overall conclusion is that while certain dental irregularities show a relationship with speech disorders, this does not appear to correlate with the severity of the malocclusion. There is no definitive proof that alteration of tooth position can improve articulation disorders.

Key Words: Malocclusion, Speech

Speech may be defined as a com-plex psycho-physiologi cal pro-cess for putting thoughts into words and organizing these words into a sequence with grammatical context. The physiological media of speech are respiratory, phonatory, and articulatory. The teeth, in conjunction with the lips and tongue, play an important role in the articulation of consonants by air-flow obstruction and modification. Therefore, tooth position may play a role in articulatory speech disorders, which although not the most severe, represent 50% to 60% of all speech disorders.[1]

The question as to whether tooth position can influence speech is clearly of interest to the orthodontist. The next logical question is whether alteration of tooth position plays a role in the correction of speech disorder. Potentially, speech disorders could become an indication for orthodontic and other specialist dental intervention, with speech correction as a primary goal. This could also have implications on the timing of orthodontic treatment. Many individuals achieve normal speech despite abnormal tooth position, which suggests the potential for compensatory mechanisms.

A complex relationship clearly exists between speech and tooth position. Harvold[2] suggested three possible mechanisms by which malocclusion and speech may be interrelated:

1. There may be an occlusal and/or skeletal problem and coincidentally an articulatory problem.
2. There may be a genetic or metabolic disorder affecting the central nervous system, which will lead to poor motor control and possible distorted morphogenesis.
3. There may be a true cause-and-effect where occlusal or structural anomalies affect articulatory skills.

Malocclusion and speech

Fymbo[3,4,5] undertook one of the first scientific investigations of a relatively unselected population. He examined in detail the occlusions of 410 students and analyzed their speech. There was no meaningful analysis of the results, but some trends were identified. Students with a malocclusion had more difficulty with dental sounds than those with normal occlusion. The severity of the speech defect was found to vary directly with the severity of the dental anomaly.

Evidence from Frowine and Moser[6] with a small case series showed that irrespective of malocclusion, patients presented with satisfactory speech.

Author Address
Dr J. R. Sandy
Division of Child Dental Health
University of Bristol Dental School
Lower Maudlin Street
Bristol, UK BS1 2LY
Email: Jonathan.Sandy@bris.ac.uk

Nicola C. L. Johnson, BDS, FDS RCS, career registrar in orthodontics, Bristol Dental School, University of Bristol, UK.

Jonathan R Sandy, PhD, FDS, MOrth RCS, reader/consultant in orthodontics, Bristol Dental School, University of Bristol, UK.

Submitted: July 1998, **Revised and accepted:** January 1999

Angle Orthod 1999;69(4):306-310.

Rathbone[7] felt that "without question," poor speech and malocclusion were related, but there was no direct relationship between the severity of the malocclusion and the severity of speech defects in a small sample.

In a more extensive study of 101 school children attending speech therapy clinics, Hopkin and McEwen[8] found that, in general, speech defects were just as likely to occur in subjects with normal occlusion as in those with malocclusion. A slightly more sophisticated approach[9] involving a randomized longitudinal study of speech, occlusion, and swallowing in elementary school children found that articulation variations showed a progressive increase, from 62% in grade 1 to 71% in grade 5. Malocclusions, however, showed a more dramatic increase, from 23% in grade 1 to 71% in grade 5.

Oliver and Evans[10] examined 35 dental students for precise oral morphology, measuring arch width, arch length, palate height, and volume. These were grouped into normal and poor articulators. They found that poor articulators had more "normal" dental features than normal articulators. Mandibular movements during speech can be examined using a kinesiograph. In a study of nearly 100 dental students, Howell[11] found an elongated envelope of movement for all malocclusions. Four distinct patterns correlated well with incisor classification. There were, interestingly, no articulatory problems within the group as a whole.

A series of publications by Laine[12-14] and Laine and co-workers[15] explored oral morphology in 451 dental students and related it to speech disorders. This approach has the advantage of examining a relatively unselected population. However, this work originated in Finland, and it raises the question of the influence of language in the production of phonemes. If this is a factor, then comparisons between populations are difficult. Laine[13] addressed this issue and found that the same sounds tended to be distorted in Finnish as in other languages.

It seems then that there may be an association between tooth position and speech, but there is enormous potential for compensation. These Finnish studies highlight the need for structured research, focusing in detail on (abnormal) tooth positioning, to more fully understand the complex relationship.

Occlusal traits and speech

One might expect labial segment tooth positions and relationships to be the most likely to influence articulation. However, buccal segment relationships, both transverse and anteroposterior, have also been implicated. Exactly how these variations, and indeed other irregularities such as tooth position or spacing, affect speech is not fully understood, but the associations of speech and various occlusal traits will now be examined.

Class II relationships

The relationship between increased overjet and speech disorders was disputed by earlier investigators due to observations of compensatory movements to allow normal speech despite abnormal anatomical relationships. Cephalometric radiography and cineradiographic techniques were employed to study the nature of these compensatory mechanisms. Blyth[16] investigated 200 children attending an orthodontic department. Orthodontic and speech analyses were carried out, and he concluded that skeletal morphology had little if any influence on the production of interdental sigmatism due to compensation. Subtelny and others[17] and Jensen[18] found that tongue position was adapted to compensate for Class II Division 1 malocclusion, rather than mandibular movement. In contrast, Benediktsson[19] found that subjects with increased overjet protruded the mandible to a greater extent than a normal occlusion group in production of the /s/ sound. One interesting study[20] showed significant differences in lip position, incisor position, and tongue position, within and between speakers, during production of the /s/ sound, depending on phonetic context.[20] This may help explain the discrepancy in the literature.

More recently, Laine and coworkers[15] found a significant relationship between increased overjet and distortions of the /s/ sound and sounds produced too far anteriorly. However, no clear relationship was found for postnormal buccal segment relationships.[13]

Class III relationships

Class III subjects often have a tongue posture that is habitually low and somewhat flaccid. Constriction of the linguoalveolar valve necessary for sibilants is therefore not produced effectively. Bloomer[21] suggested that this causes no difficulty in speech if the condition is relatively mild, and even a considerable discrepancy may cause no problems.

In a cephalometric study of 12 adolescent subjects with full anterior crossbites, Guay[22] concluded that subjects had a lower and more retruded tongue posture at rest than normal. During phonation of /s/, the tongue was retruded, apparently attempting to achieve a normal tongue-tip-to-upper-incisor relationship. Despite compensatory movements, normal /s/ production was found in only one subject.

Laine[13] found that the mesial location of the mandibular dentition was related to misarticulation of some medioalveolar consonants. In further work, Laine[14] suggested that the risk ratios for producing

consonants too far anteriorly was increased 4.5 times in subjects with mesial occlusion, and 3.7 times in those with mandibular overjet. Possibly the volume of the posterior part of the oropharynx complicates adequate placement of the tongue.

Anterior openbite

Anterior openbite is the occlusal trait most often implicated in misarticulations; indeed, Fymbo[3] suggested that 63% of those with openbite had defective speech, and only 4% had superior speech. In a fairly extensive study, Bernstein[23] examined 437 school children with speech problems and matched them to a control group of similar size and age. Occlusion was assessed according to Angle's classification as well as a subcategory of openbite. He concluded that speech defects are not related to malocclusion generally except in openbites, where there is a strong relationship with lisping. The severity of the lisping does not seem to vary with the extent of the openbite. In a similar study, Pomerantz and Zeller[24] concluded that openbite or edge-to-edge occlusion was significantly related to defective speech sounds, in particular /s/, /z/, /th/, and /l/.

Laine[13] found anterior openbite was associated with an anterior misarticulation of the /s/ sound. The risk for producing consonants too far anteriorly was increased 3.4 times in subjects with anterior openbite.[1] However, incisal openbite alone is rarely associated with articulatory speech disorders, and when present, they tend to be mild. When combined with other occlusal anomalies, especially mesial occlusion, anterior openbite is related more often to more severe misarticulations.

Increased overbite

There is conflicting evidence on the relationship between misarticulations and deep overbite. Lubit[25] studied 300 consecutive patients using occlusal and speech analysis. He found a statistically significant relevance between misarticulation of /s/ sounds and deep overbite, but this was negligible when considering overall articulatory ability.

Ingervall and Sarnas[26] examined the relationship of lisping and dental malocclusion and found a tendency for increased overbite to be associated with lateral lisping. Conversley, Laine[13,15] found no evidence of any relationship between increased overbite and speech defects.

Lateral tooth position and speech

The relationships between articulatory disorders and reduced maxillary dimensions,[10] a narrow palate,[12] and lateral crossbite[13] have been explored. The size of the mandibular dental arch has not been linked to any articulatory speech disorders,[12] although the risk ratio for producing consonants too far anteriorly was given as 1.7 times greater for those with lateral crossbite compared with individuals without occlusal anomalies.

Others dispute this relationship,[25,27,28] and some difficulties arise when studies are compared because of variations in measuring points and varying appreciation that palatal dimensions are affected by sexual dimorphism. The reported associations are weak, which might indicate that lateral dimensions are only one of many etiological factors.

Other dental irregularities

The literature seems to suggest an association between speech defects and upper anterior spacing[3] or missing maxillary incisors.[29,30] Laine[15] reported that spacing of maxillary incisors was associated with articulatory disorders of /l/, /n/, and /d/ sounds, or anterior or lateral variants of the /r/ sound. However, there appear to be compensatory mechanisms, and normal speech is achieved by many with anterior spacing.[30,31] No relationship seems to exist for mandibular incisor spacing, nor upper or lower arch crowding.

An interesting longitudinal investigation of school children 9 to 11 years old found that neither developmental stage of the dentition nor age was related to articulatory speech disorders.[32]

Alteration of tooth position and speech

The impact of orthodontic treatment on speech has been studied in two ways. The first is the transient effect of removable appliances, which is similar to placement of dentures and is not considered further here. The second involves the response of speech problems to corrective orthodontic therapy, where there is a surprising paucity of literature.

Kessler[33] observed that when the occlusion is corrected in an individual with defective speech, the speech often improves. Rathbone and Snidecore[34] examined the effects of orthodontic treatment on eight patients over a 4-year period, with no speech therapy intervention. At the beginning of treatment, there was a mean of 6.4 faulty sounds, and at the end only 1.5. The same fricative /s/, /z/, /sh/, and /zh/ sounds tended to remain faulty.

A more sophisticated prospective randomized controlled trial examined 25 subjects seeking treatment for functional voice disturbances. Subjects were randomly allocated to treatment or placebo groups.[35] The treatment subjects underwent occlusal adjustment to eliminate all interferences and were examined after 2 months. The treatment group showed improvement in voice status, while the placebo group remained unchanged.

Orthognathic surgery and speech

The role of orthognathic surgery in the correction of malocclusion is complex, principally because there are corrections in tooth position as well as jaw position. One of the earliest comments came from Higley,[36] who presented two case reports of patients who had undergone mandibular surgery; the general intelligibility of speech improved in one patient, but the second merely substituted an anterior stigmatism for a lateral one. Goodstein[37] found no change in speech in five patients who had undergone a reduction in mandibular length. Speech errors may actually increase after surgery as the jaw is placed in a new position.[38] A more extensive study by Dalston and Vig[39] found that there was no postoperative alteration of speech in 40 female orthognathic patients. In a significant review, Ruscello[40] concluded that surgical alteration of the morphology of the oral cavity does alter the articulators and improves previously distorted speech. Yamaguchi,[41] in a videotaped speech analysis, found that most of the 15 adult Japanese patients who had had surgery to correct a mandibular prognathism showed clear improvement. There was no statistical analysis of the data, and the need for focused scientific investigation in this area is pressing. Currently, the evidence is equivocal, and certainly no guarantees of improvement can be given to patients undergoing orthodontic or orthognathic correction of a malocclusion.

Conclusions

Many of the traditionally associated links between occlusal traits and speech problems do not have a scientifically sound research basis. The research problem is fraught with difficulties. Speech is an activity unique to humans, and animal experimentation has almost no place in the study of speech production. The available studies fall into three categories:

1. Subjects with speech problems examined for malocclusion
2. Subjects with malocclusion examined for speech problems
3. Unselected populations studied for coincidental malocclusion and speech difficulties.

Only the last category offers the benefits of nonselection, but many of these studies have been carried out on undergraduate students, which may introduce bias. In addition, there are varying methodologies for specifying articulation defects/distortions/disorders and for identifying malocclusions. Reliability and validity of these measures are seldom reported. Comparisons between different populations and different linguistic areas also present difficulties.

The importance of evaluating individual malocclusion traits is clear. The most consistently reported traits are Class III arch relationships, anterior openbite, increased overjet, and spacing. However, there is no clear evidence of a direct relationship between severity of malocclusion and severity of misarticulation.

Some sounds seem more sensitive to alterations of the oral structures than others. This may relate to the order of difficulty of individual sound production, since the sounds acquired last are those most often reported as distorted.

The ability to adapt and compensate appears to play a significant role. Bloomer[42] summarized this well:

Normal structure + normal function = normal speech

Abnormal structure + adaptive function = normal speech

Abnormal structure + no adaptive function = abnormal speech

Normal structure + abnormal function = abnormal speech

Thus, the recommendation is to consider speech carefully when examining and assessing a patient. Recognition of commonly misarticulated sounds should be possible during normal conversation, and any potential relationship to malocclusion made. There is no substantial evidence that orthodontic treatment will influence any articulation disorders, and in such cases co-operation with a speech therapist is essential.

References

1. Van Riper C. Speech correction: Principles and methods. New Jersey: Prentice Hall, 1978.
2. Harvold EP. Speech articulation and oral morphology. Am Speech Hearing Assoc 1970; Report No.5:69-75.
3. Fymbo LH. The relation of malocclusion of the teeth to defects of speech. Arch of Speech 1936;1:204-16.
4. Fymbo LH. A study of the relation of malocclusion to articulatory defective speech, part 1. Iowa State Dent J 1956;42:288-94.
5. Fymbo LH. A study of the relation of malocclusion to articulatory defective speech, part 2. Iowa State Dent J 1957;43:8-13.
6. Frowine von K, Moser H. Relationship of dentition and speech. J Am Dent Assoc 1944;31:1081-89.
7. Rathbone JS. Appraisal of speech defects in dental anomalies. Angle Orthod 1955;25:42-48.
8. Hopkin GB, McEwen JD. Speech defects and malocclusion: A palatographic investigation. Dent Pract 1956;6:123.
9. Jann GR, Ward MM, Jann HW. A longitudinal study of articulation, deglutition and malocclusion. J Speech Hearing Dis 1964;29:424-35.
10. Oliver RG,Evans SP. Tongue size, oral cavity size and speech. Angle Orthod 1986;56:234-43.
11. Howell PGT. The variation in the size and shape of the human speech pattern with incisor-tooth relation. Arch Oral Biol 1987;32:587-592.
12. Laine T. Articulatory disorders in speech as related to the size of alveolar arches. Eur J Orthod 1986;8:192-97.
13. Laine T. Associations between articulatory disorders in speech and occlusal anomalies. Eur J Orthod 1987;9:144-50.
14. Laine T. Malocclusion traits and articulatory components of speech. Eur J Orthod 1992;14:302-9.
15. LaineT , Jaroma M, Linnasalo AL. Relationships between interincisal occlusion and articulatory components of speech. Folia Phoniatrica 1987;39:78-86.
16. Blyth P. The relationship between speech, tongue behaviour, and occlusal abnormalities. Dental Pract 1956;20:11-20.

17. Subtelny JD, Mestre JC, Subtelny JD. Comparative study of normal and defective articulation of /s/ as related to malocclusion and deglutition. J Speech Hearing Dis 1964;29:264-85.
18. Jensen R. Anterior teeth relationship and speech. Acta Rad Suppl 1968;276:1-69.
19. Benediktsson E. Variation in tongue and jaw position in /s/ production in relation to front teeth occlusion. Acta Odont Scand 1958;15:275-303.
20. Subtelny JD, Oya N, Subtelny JD. Cineradiographic study of sibilants. Folia Phoniatrica 1972;24:30-50.
21. Bloomer HH. Speech defects associated with dental malocclusion and related abnormalities. Handbook of Speech Pathology. New York: Appleton-Century-Croft, 1971.
22. Guay AH, Maxwell DL, Beecher R. A radiographic study of tongue posture at rest and during the phonation of /s/ in Class III malocclusion. Angle Orthod 1978;48:10-22.
23. Bernstein M. The relation of speech defects and malocclusion. Am J Orthod 1954;40:149-50.
24. Pomerantz J, Zeller AJ. Speech, occlusion and tongue function in elementary school children. Am J Orthod 1965;51:312-13 (Abstract).
25. Lubit EC. The relationship of malocclusion and faulty speech articulation. J Oral Med 1967;22:47-55.
26. Ingervall B, Sarnas KV. Comparison of dentition in lispers and non-lispers. Odont Revs 1962;13:344-54.
27. Fairbanks G, Lintner MVH. A study of minor organic deviations in "functional" disorders of articulation: 4. The teeth and hard palate. J Speech Hearing Dis 1951;16:273-79.
28. Wardlaw FO. A study of the relation of the height and width of hard palate to articulatory defects of speech. Am J Orthod 1962;48:789-90 (Abstract).
29. Snow K. Articulation proficiency in relation to certain dental abnormalities. J Speech Hearing Dis 1961;26:209-12.
30. Bankson NW, Byrne MC. The relationship between missing teeth and selected consonant sounds. J Speech Hearing Dis 1962;27:314-48.
31. Weinberg B. A cephalometric study of normal and defective /s/ articulation and variations in incisor dentition. J Speech Hearing Res 11:288-300.
32. Kirveskari P, Jaroma M, Laine T. Occlusal adjustment in the treatment of functional voice disorders. J Craniomandib Pract 1988;6:327-29.
33. Kessler HE. The speech of your young dental patients. Dental Survey 1951.
34. Rathbone JS, Snidecore JC. Appraisal of speech defects in dental anomalies with refence to speech improvement. Angle Orthod 1959;29:54-59.
35. Pahkala R, Laine T, Narhi M. Associations among different orofacial dysfunctions in 9-11 year olds. Eur J Orthod 1995;17:497-503.
36. Higley G. Facial reconstruction and speech. J Am Dent Assoc 1943;30:1716-25.
37. Goodstein DB, Cooper D, Wallace L. The effect on speech of surgery for correction of mandibular prognathism. Oral Surg Med Rehab 1974;37:846-49.
38. Garber SR, Speidel TM, Morse G. The effects on speech of surgical premaxillary osteotomy. Am J Orthod 1981;79:54-61.
39. Dalston RM, Vig PS. Effects of orthognathic surgery on speech: A prospective study. Am J Orthod 1984;86:291-98.
40. Ruscello DM, Teklieli ME, Van Sickels JE. Speech production before and after orthognathic surgery: A review. Oral Surg Oral Med Oral Path 1985;59:10-14.
41. Yamaguchi H, Tanaka Y, Sueishi K, Sebata M, Uchiyama T, Saito C, Sigematsu T. Changes in oral functions and muscular behaviour due to surgical orthodontic treatment. Bulletin of the Tokyo Dental College 1994;35:41-49.
42. Bloomer HH. Speech defects associated with dental abnormalities and malocclusions. Handbook of Speech Pathology. New York: Appleton-Century-Croft, 1957.