Taiwanese Journal of Orthodontics

Volume 30 | Issue 2 Article 4

2020

Curve of Spee: Development and Orthodontic Leveling

Yu-Hsin Lee
School of Dentistry, College of Dental Medicine, Kaohsiung Medical University; Department of Orthodontics, Dental Clinics, Kaohsiung Medical University Memorial Hospital

Yu-Chuan Tseng
School of Dentistry, College of Dental Medicine, Kaohsiung Medical University; Department of Orthodontics, Dental Clinics, Kaohsiung Medical University Memorial Hospital, tsengyc@kmu.edu.tw

Review Article

Curve of Spee: Development and Orthodontic Leveling

Yu-Hsin Lee,[1,2] *Yu-Chuan Tseng*[1,2]

[1] *School of Dentistry, College of Dental Medicine, Kaohsiung Medical University*

[2] *Department of Orthodontics, Dental Clinics, Kaohsiung Medical University Memorial Hospital*

Curve of Spee (CoS) is characterized as human occlusal curvature viewed in the sagittal plane. This naturally occurring phenomenon has clinical importance in orthodontics and prosthodontic dentistry. The purpose of this article is to examine the formation of the CoS regarding of when, how, or why the CoS develops. The mechanism of orthodontic leveling the CoS will be discussed. ***(Taiwanese Journal of Orthodontics. 30(2): 98-103, 2018)***

Keywords: Curve of Spee; craniofacial morphology; orthodontic treatment.

DEFINITION

Curve of Spee (CoS) is a naturally occurring phenomenon in the human dentition. This normal occlusal curvature is required for an efficient masticatory system. Found in the dentitions of other mammals and fossil humans, this curvature was termed the "curve of Spee" in the late 19th century, when Ferdinand Graf von Spee described it in humans.[1] He used skulls with abraded teeth to define the line of occlusion as the line on a cylinder tangent to the anterior border of the condyle, the occlusal surface of the second molar, and the incisal edges of the mandibular incisors.[2] Currently, in orthodontics, CoS commonly refers to the arc of a curved plane that is tangent to the incisal edges and the buccal cusp tips of the mandibular dentition viewed in the sagittal plane. In contrast, the prosthodontic specialty ignores the incisors and includes only the canines to the terminal molars as the dental arch portion of the curve. This anterior-posterior curve - i.e., CoS - was defined in the *Glossary of Prosthodontics* as the "anatomical curve established by the occlusal alignment of the teeth (Figure 1), as projected onto the median plane, beginning with the cusp tip of the mandibular canines and following the buccal cusp tips of the premolars and molar teeth, continuing through the anterior border of the mandibular ramus and ending at the anterior aspect of the mandibular condyle.[3]

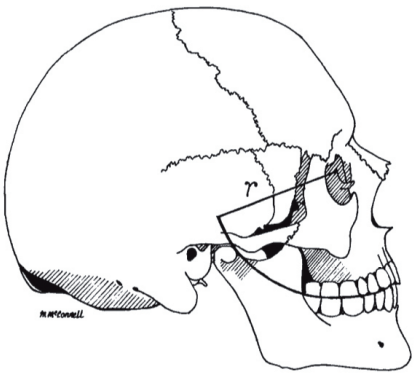

Figure 1. *The curve of Spee. (Reproduced by Dr. Mary McConnell from Spee FG. Die Verschiebungsbahn des Unterkiefers am Schädel. Arch Anat Physiol 1890;16:285-94)*

Received: March 14, 2018 Revised: May 18, 2018 Accepted: May 22, 2018

Reprints and correspondence to: Dr. Yu-Chuan Tseng, 100 Shih-Chuan 1st Road, Kaohsiung 80708, Taiwan

Tel: +886-7-3121101 ext 7009 Fax: +886-7-3221510 E-mail: tsengyc@kmu.edu.tw

DEVELOPMENT

The description of how the CoS develops is limited in the literature. The developmental and functional significance of the CoS had been investigated by several researchers. Some have suggested that its development probably results from a combination of factors including growth of orofacial structures, eruption of teeth, and development of the neuromuscular system.[4] It has been suggested that the mandibular sagittal and vertical position relative to the cranium is related to the CoS, which is presented in various forms in mammals. In humans, an increased CoS is often observed in brachycephalic facial pattern and is associated with short mandibular bodies.[5,6] In a mechanical sense, the presence of a CoS may make it possible for a dentition to resist the forces of occlusion during mastication. Although several theories have been proposed to explain the presence of a CoS in natural dentitions, its role during normal mandibular function has been questioned. It has been proposed that an imbalance between the anterior and the posterior components of occlusal force can cause the lower incisors to over-erupt, the premolars to infra-erupt, and the lower molars to be mesially inclined.[7,8] In describing the 6 characteristics of normal occlusion, Andrews[9] found that the CoS in subjects with good occlusion ranged from flat to mild, noting that optimal static intercuspation occurred when the occlusal plane was relatively flat. The author proposed that flattening the occlusal plane should be a treatment goal in orthodontics. This concept, especially applied to the correction of deep overbite, has been supported by others and produces variable results with regard to maintaining a level curve after treatment.

DECIDUOUS TEETH VERSUS PERMANENT TEETH

It has been suggested that the deciduous dentition has a CoS ranging from flat to mild, whereas the adult CoS is more pronounced. On average, eruption of the mandibular permanent first molars precedes that of the maxillary permanent first molars by 1 to 2 months, and eruption of the mandibular permanent central incisors precedes that of the maxillary permanent central incisors by 12 months.[10] Moreover, the mean age for the eruption of the mandibular second molars is 6 months before the maxillary second molars. This difference in tooth eruption timing could permit unopposed mandibular permanent first molar and incisor eruptions beyond the established mandibular occlusal plane.10 The greatest increase in CoS occurs in the early mixed dentition as a result of permanent first molar and central incisor eruption. It maintains this depth until it increases to maximum depth with eruption of the permanent second molars, and then remains relatively stable into late adolescence and early adulthood.[11-13] These findings also support those of Carter and McNamara[11] and Bishara et al,[12] that once established in adolescence, the CoS appears to be relatively stable.

GENDER-RELATED VARIATION OF CoS

Marshall et al reported that there are no significant differences in maximum depth of CoS between either the right and left sides of the mandibular arch, or according to gender.[10] Carter and McNamara reported that no difference in depth of the CoS between male and female subjects when it was measured from dental casts taken before treatment.[11]

AGE-RELATED CHANGES IN CoS

The present review found that no evidence supported the inter-relationship between CoS and age. It was reported that the depth of the CoS was stable throughout adolescence and into adulthood.[14,15,16] The effect of age on CoS has been investigated in growing subjects up to young adulthood. However, to our knowledge, there are no available data regarding variation of CoS with age

in adults. With increasing of age, it can be expected that homogeneous dental wear may occur as a consequence of masticatory function. It is interesting to note that the CoS could be observed in most primates and mammals, regardless of the extent of tooth wearing.[17,18] Tooth wear does not appear to affect the forward tilt of the posterior teeth in the sagittal plane. Although the cusps become flat gradually, the CoS is maintained throughout the years.[19]

DENTAL RELATIONS RELATED TO CoS

In the study of Veli et al, depth of the CoS was greatest in the Class II division 1 malocclusion group, followed by Class II division 2, Class I, and Class III malocclusion.[20] Shannon and Nanda reported that patients with a Class II malocclusion had a significantly deeper CoS than those with a Class I malocclusion.[21] A similar study examined 100 untreated patients and also reported that the CoS was the most severe in the Class II division 2 patients, followed by Class II Division 1, Class I, and Class III patients.[22]

The CoS is deeper in individuals with Class II malocclusions with consensus. Some Class III patients may have deep Cos, it could be assumed that Class III patients with a negative increased overjet exhibit greater eruption of the anterior teeth because of uncovering.[20] Thus, CoS has a direct relationship with the anterio-posterior position of maxilla and mandible.

INFLUENCE OF CRANIOFACIAL MORPHOLOGY ON THE CoS

According to a previous study, the influence of craniofacial morphology on the CoS has been systematically investigated in very few studies and with conflicting findings. Kumar and Tamizharasi reported that the CoS was influenced only to a minor extent by craniofacial morphology.[1] On the other hand, Farella et al reported that condylar height (relative to the occlusal plane) and anteroposterior position of the mandible (relative to the cranial base) are associated with CoS depth.[19] Based on the results reported by Southard[10] and Farella et al,[19] in patients with small mandibles, the mandibular permanent incisors would keep erupting (i.e., CoS increasing) until they contact the palate.

Farella et al also reported that the CoS was also influenced by the position of the mandible with respect to the anterior cranial base (i.e., SNB angle), regardless of the reciprocal position of the lower and upper jaw in the sagittal plane (ANB angle).[19] The more the mandible was forward positioning, the less marked the Cos. Orthlieb found that the radius of the CoS was shorter in Class III than in Class II malocclusions.[23]

LEVELING OF THE CoS

Correction of exaggerated CoS can achieve by extrusion of molars, intrusion of incisors, or combination of the above tooth movement. Before starting this orthodontic treatment, a precise diagnosis must be decided which mechanics to be used. If patients have short lower facial height (orthodivergent to hypodivergent facial pattern), excessive CoS, moderate-to-minimal incisor display and deep overbite, it is suitable for molar extrusion. One millimeter of molar extrusion could reduce the incisor overlap by 1.5 to 2.5 mm. Use the continuous archwires to level the Cos is common and simple,[24] such as the use of 0.016 × 0.022" reverse curve NiTi wire (Figure 2). However, flaring of the incisors is the disadvantage of continuous archwires. Second, wire bending with increasing step bends in an archwire, can also level the CoS. A third method was the use of a lever arm (Figure 3) and intrusive arch, which could not only extrude the posterior teeth but also intrude the anterior teeth. The CoS can also be levelled by using a bite plate, which enables the posterior teeth to erupt. Although all of these methods can help to correct an exaggerated CoS, the stability of molar extrusion is questionable in non-growing patients.

Figure 2. *The lower anterior teeth were intruded by 0.016X0.022" reverse NiTi wire for leveling the Cos.*

Figure 3. *The upper and lower anterior teeth were intruded by 0.016X0.022" SSW lever arm for opening the deep bite and leveling the Cos.*

Intrusion of the upper and/or lower incisors is a desirable method to level CoS in many adolescent and adult patients. It is particularly indicated for patients with an excessive mandibular plane angle, hyperdivergent facial pattern, excessive incision-stomion distance, and a large interlabial gap. The methods for intruding the anterior teeth include modification of bracket bonding position, a utility arch without tie back, intrusion bend, lever arm, and 0.016 × 0.022" reverse NiTi wire. If more intrusion is required, temporary anchorage devices could be provided as an absolute anchorage. A major risk factor associated with intrusion of anterior teeth is external apical root resorption. In some cases, intruding anterior teeth may even worsen in patients with periodontal compromised condition.

CONCLUSION

The comprehension of CoS development and its correction is important for orthodontic daily practice. However, there is little solid information of the etiology, development, and influencing factors of excessive CoS in literatures. Hence, further researches are required for CoS investigation. Leveling of the CoS depends on different dental parameters based on skeletal vertical facial patterns. In patients with low mandibular plane angle, orthodontic leveling of the CoS occurs through extrusion of buccal segment, intrusion and buccal movement of the mandibular incisors. In patients with high mandibular plane angle, orthodontic leveling of the CoS occurs through intrusion of the mandibular anterior teeth. Extruding buccal segment in patients with high mandibular plane angle may worsen the facial profile.

REFERENCES

1. Kumar KP and Tamizharasi S. Significance of curve of Spee: An orthodontic review. *J Pharm Bioallied Sci*. 2012;4(Suppl 2):323–8
2. Spee FG, Biedenbach MA, Hotz M, Hitchcock HP. The gliding path of the mandible along the skull. *J Am Dent Assoc*. 1980;100:670–5.
3. Van Blarcom CW. Glossary of Prosthodontics terms, 8th ed. St. Louis: Mosby 2005.
4. Osborn JW. Orientation of the masseter muscle and the curve of Spee in relation to crushing forces on the molar teeth of primates. *Am J Phys Anthropol*. 1993;92:99–106.
5. Wylie WL. Overbite and vertical facial dimensions in terms of muscle balance. *Angle Orthod*. 1994;19:13–7.
6. Björk A. Variability and age changes in overjet and overbite. *Am J Orthod*. 1953;39:779–801.
7. Strang RHM and Thompson WM. A Textbook of Orthodontia. Philadelphia: Lea and Fiebiger; 1958. p.335-61
8. Gresham H. A manual of orthodontics. Christ Church: N.M. Peryer; 1957.
9. Andrews LF. The six keys to normal occlusion. *Am J Orthod*. 1972;62:296–309.
10. Marshall SD, Caspersen M, Hardinger RR, Franciscus RG, Aquilino SA, Southard TE. Development of the curve of Spee. *Am J Orthod Dentofacial Orthop*. 2008;134:344–52.
11. Carter GA, McNamara JA Jr. Longitudinal dental arch changes in adults. *Am J Orthod Dentofacial Orthop*. 1998;114(1):88–99.
12. Bishara SE, Jakobsen JR, Treder JE, Stasi MJ. Changes in the maxillary and mandibular tooth size-arch length relationship from early adolescence to early adulthood. A longitudinal study. *Am J Orthod Dentofacial Orthop*. 1989;95(1):46–59.
13. Veli I, Ozturk MA, Uysal T. Development of the curve of Spee in Class II subdivision malocclusion: a longitudinal study. *Eur J Orthod*. 2015;37(4):412–7.
14. Ferrario VF, Sforza C, Poggio CE, Serrao G, Colombo A. Three-dimensional dental arch curvature in human adolescents and adults. *Am J Orthod*. 1999;115(4):401–5.
15. Enlow DH. Normal variations in facial form and the anatomic basis for malocclusion. In: Enlow, DH, ed. *Facial growth,* 3rd edn. Philadelphia: WB Saunders, 1990:193–221.
16. Osborn JW, Francis LJ. The position of the dentition in the mandible and its possible relation to orthodontic abnormalities. *Am J Orthod*. 1989;96(4):327–32.
17. Osborn JW. Relationship between the mandibular condyle and the occlusal plane during hominid evolution: some of its effects on jaw mechanics. *Am J Phys Anthropol*. 1987;73(2):193–207.
18. Baragar FA, Osborn JW. Efficiency as a predictor of human jaw design in the sagittal plane. *J Biomech*. 1987;20(5):447–57.
19. Farella M, Michelotti A, van Eijden TM, Martina R. The curve of Spee and craniofacial morphology: a multiple regression analysis. *Eur J Oral Sci*. 2002;110(4):277–81.
20. Veli I, Ozturk MA, Uysal T. Curve of Spee and its relationship to vertical eruption of teeth among different malocclusion groups. *Am J Orthod Dentofacial Orthop*. 2015;147(3):305–12.
21. Shannon KR, Nanda RS. Changes in the curve of Spee with treatment and at 2 years posttreatment. *Am J Orthod Dentofacial Orthop*. 2004;125(5):589–96.
22. Ahmed I, Nazir R, Gul-e-Erum, Ahsan T. Influence of malocclusion on the depth of curve of Spee. *J Pak Med Assoc*. 2011;61(11):1056–9.
23. Orthlieb JD. The curve of Spee: understanding the sagittal organization of mandibular teeth. *Cranio*. 1997;15(4):333-340.

24. Weiland FJ, Bantleon HP, Droschl H. Evaluation of continuous arch and segmented arch leveling techniques in adult patients – a clinical study. *Am J Orthod Dentofacial Orthop*. 1996;110(6):647–52.