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CURVE OF SPEE: A LITERATURE REVIEW.

CURVA DE SPEE: UMA REVISÃO DE LITERATURA.

Elias, KFL*
Denis Clay Lopes dos Santos**
Daniel Negrete***
Everton Flaiban****

ABSTRACT

The curve of Spee (COS) is an important characteristic of the dental arch that was described as an occlusal curvature seen in the sagittal plane. This natural phenomenon has clinical importance in orthodontics and restorative dentistry. This study aim to gather the current knowledge of COS in order to become a guide for a construction of an optimal occlusion. The methodology utilized was a review and compilation of the most pertinent literature articles. The following were deliberated in this review: development, measurement, evolutive similarities, gender, side, properties, the purpose of levelling, the sorts of levelling and the long-term stability of the COS. In conclusion, although a large amount of research on COS already exists, there is no standard methodology to define an ideal model of treatment and/or prevention. Nevertheless, its results give dentists a complete overview to establish their approach towards a successful long-term stability treatment.

Descriptors: Dental occlusion • Curve of Spee • Intrusion • Extrusion • Levelling; Stability.

RESUMO

A Curva de Spee é uma característica importante da arcada dentária e foi descrita como uma curvatura oclusal vista a partir do plano sagital. Esse fenômeno natural é de grande importância clínica especialmente em ortodontia e em dentística. Este estudo tem como objetivo compilar o atual conhecimento sobre a Curva de Spee com intenção de se tornar um guia para o desenvolvimento de uma oclusão eficiente. A metodologia utilizada foi revisão de literatura sobre a Curva de Spee e os tópicos discutidos são: desenvolvimento, mensuração, similaridades evolutivas, gênero, comparação entre lados, propriedades, o propósito do nivelamento, as maneiras de se nivelar e a estabilidade a longo prazo. Apesar do grande número de pesquisa sobre a Curva de Spee, não existiu um padrão de metodologia ou mensuramento para definir um modelo ideal para tratamento e/ou prevenção. Como conclusão, este artigo fornece uma ampla visão para capacitar o cirurgião-dentista em direção a um tratamento de sucesso e de estabilidade.

Descritores: Oclusão dentária • Curva de Spee • Intrusão • Extrusão • Nivelamento • Estabilidade.

* Dentist - kfelias@hotmail.com
** Ph.D. in Orthodontics - Orthodontics professor at School of Dentistry, Universidade Cruzeiro do Sul, São Paulo, Brazil - dr.denis@globomail.com
*** Master in Orthodontics - Orthodontics professor at School of Dentistry, Universidade Cruzeiro do Sul, São Paulo, Brazil - +55 11 99922-5415
**** Master in Orthodontics - Orthodontics professor at School of Dentistry, Universidade Cruzeiro do Sul, São Paulo, Brazil - +55 11 97036-8808

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INTRODUCTION

Curve of Spee (COS) is an anatomic curvature of the mandibular dental arch seen in the sagittal plane described by Graf Von Spee, a prosector at the Anatomy Institute of Kiev, in 1890 and Biedenbach, Hotz and Hitchcock have recently represented it in 1980[1]. This natural phenomenon has clinical importance for an ideal functional occlusion, thus far it provides a small understanding of the reasons it occurs.

The aim of this study is to issue a compendium of the pre-existent knowledge into a guide for orthodontics and restorative dentistry appliances about development, management and the long-term stability of COS.

METHODOLOGY

To prepare this project PubMed/MEDLINE, Cochrane and Scopus sciences were utilized as biomedical search engines. The searching term used was COS with helping the truncation symbol * on the word curv*. The research was restricted to English, Portuguese and Spanish languages and no other limited methodology had been employed. The articles were selected according to the applicability of this study.

DISCUSSION

Spee predicted the curvature from a sagittal view analysing the skulls 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[1]. The definition of the COS for prosthodontics is an anatomic anteroposterior curve established by the occlusal alignment of the teeth, as projected onto the median plane, beginning with the cusp tip of the mandibular canine and following the buccal cusp tips of the premolar and molar teeth, continuing through the anterior border of the mandibular ramus, ending with the anterior-most portion of the mandibular condyle[2] . Despite the understanding of the reason why and how the COS exist is limited, it is believed that the COS is a combination of factors, including growth of orofacial structures, development of the neuromuscular system, and eruption of teeth[3].

Spee on his studies suggested that this geometric arrangement defined the most efficient pattern for maintaining maximum tooth contacts during chewing[1]. This statement became the foundation for Monson's spherical theory on the idealistic arrangement of the teeth in the dental arch[4].

More recently, it was advocated that the COS have a biomechanical function during food processing by increasing the crush/shear ratio between the posterior teeth and the efficiency and resistance of occlusal forces during mastication[5].

Development of the Curve of Spee

It is assumed that the deciduous dentition has a COS ranging from flat to mild. The COS depth is minimal in the deciduous dentition (flat), its greatest increase 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 the eruption of the permanent second molars. During the adolescent dentition stage, the curve depth decreases slightly and then remains relatively stable into early adulthood[6, 7].

A likely theory for the development of the COS is that mandibular permanent teeth erupt before their maxillary antagonists. This means the COS is not skeletal, indeed, develops as a dental event. On average, eruption of the mandibular permanent first molars antecede the maxillary permanent first molars by 1 to 2 months, mandibular permanent central incisors precede the maxillary permanent central incisors by 12 months, and mandibular second molars are 6 months before the maxillary second molars[8].

Gender and Side Influence

In general, there is no significant difference on the COS between males and females and either the right and left sides of the mandibular arch[9, 10, 11].

Evolutive similarities

In reason of the different kinds of alimentation, two types of occlusion exist. In the case of carnivorous skulls, lateral mandibular movements are absent, the mandibular ramus is short and the COS is non-existent. On the other hand, the her-

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bivorous type has very important lateral mandibular movements, the mandibular ramus is higher and COS is deep. There is also an association between the forward tilt of the mandibular posterior teeth and the orientation of the masseter muscle[12].

Osborn, in his comparative study, concluded that the tilt of the COS increases the crush/shear ratio of the force produced on food between the posterior molars. The parallel tilt of superficial masseter maximizes the efficiency with which this muscle contributes to the crush component of the bite force in the sagittal plane[13].

Measurement of Curve of Spee

Clinically, the depth of COS is measured by a line that is positioned on the mandibular occlusal surfaces and the furthermost depth from this plane is noted. However, some authors do not include the incisors in the depth measurements because super-erupted incisors result in a greater depth of the COS[14].

Academically, the COS could be measured by a flat plane formed by the incisal edge of the mandibular central incisors to the distal cusp tip of the second molars. Perpendiculars are projected on this line from the cusp tips of all teeth in this half arch. A sum of these perpendiculars is calculated for the right and the left side[7, 15, 16, 17, 18].

It is assumed by some authors that the deepest point of the COS is the mesiobuccal cusp of the first molar independent of the sort of malocclusion.[17, 18, 19] Nonetheless, Harris and Corruccini found in their research that the commonly deepest point of the COS is on a premolar[14].

Properties of Curve of Spee

Not only is COS correlated with over-bite and overjet, but also COS is described as the deepest in class II, while it is flatter and with insignificant variances in class I and III subjects[19].

It was established by Veli, Ozturk and Uysal that the depth of the COS is greatest in the Class II Division 1, followed by Class II Division 2, Class I, and Class III. However, there is no significant difference between Class II division 1 or 2[17, 18].

Furthermore, COS is directly proportional to the overjet and over-bite of an individual. By increasing them, it will lead to a deeper COS[16] . In addition, when the anterior teeth have no vertical stop, their continued eruption will contribute to the deepening of the COS[20, 21].

The purpose of levelling the Curve of Spee

On the six characteristics of normal occlusion described by Andrews, it was proposed that the COS in subjects with good occlusion ranged from flat to mild. For this reason, it was suggested that levelling and flattening the occlusal plane should be a treatment goal in orthodontics[22]. This concept has been supported by others with regard to maintaining stable results after treatment[10, 18].

Therefore, levelling of the COS is a routine orthodontic practice and several studies have compared treatment techniques to deal with exaggerated COS and the stability of those treatments. These tooth movements are mostly extrusion of molars, the intrusion of incisors and incisor proclination[19, 21, 23, 24, 25, 26, 27 28, 29 30].

Extrusion of posterior teeth

Extrusion of posterior teeth is a possible treatment for patients with excessive COS. The most typical technique is continuous archwire[23, 28,31]. A variation of this practice is to proceed with maxillary exaggerated COS wires or/and mandibular reverse COS. Increasing step bends in an archwire similarly levels the COS. Other methods consist of the use of a bite plate, which permits the posterior teeth to erupt. In addition, altering bracket placement heights helps to level the COS as well[30] . A main concern is that every millimetre of extrusion increases the incisor overlap by between 1.5-2.5 mm[29, 30].

The indications for extrusion of posterior teeth are short lower facial height and moderate-to-minimal incisor display[29, 30]. On the other hand, the disadvantages are instability in non-growing patients, increase in the interlabial gap, excessive incisor exhibition and worsening of gingival smile[21, 30,32] . Furthermore, extruding posteriors could cause a rise in lower facial height and patients with strong facial muscles have a tendency to relapse after the orthodontic treatment[33].

Intrusion of incisors

The intrusion of incisors is a necessa-

ry method to level COS particularly for patients with a large vertical dimension, excessive incision-stomion distance and a large interlabial gap. [29, 30,34]. The four most common techniques are: Burstone[19], Begg and Kesling[35] (1977), Ricketts[36] (1976) and Greig[37] (1983).

The four methods apply tipback twists at the molars to provide an intrusive force at the incisors and recognise the extreme significance of a light and continuous force application[29, 30]. On the other hand, this orthodontic treatment has a notable risk factor associated with external apical root reabsorption[38, 39].

Incisors proclination

Incisors proclination is another option to levelling the COS. Some researchers claim that COS is predominantly flattened by proclining the lower incisors[40]. For each 1 mm of levelling, the mandibular incisors will be proclined 4°, without increasing the arch width. In addition, it is suggested that 1 mm of arch circumference is required to level each 1millimeter of the COS[26,41] . However, it is assumed by Pandis et al that the amount needed is variable depending on the type of mechanics applied[40].

Long-term stability

Flattening the COS seems to be very stable on a long-term basis[31,42, 43]. The long-term stability of the correction of COS is established by several factors, such as the amount of growth, age, neuromuscular adaptation, muscle strength, original malocclusion and the specific nature of its correction, for example intrusion or/and extrusion[30, 44].

More stability is also expected after pronounced levelling deviations of deep curves, while there is a propensity in the direction of less stability and more natural fluctuations when treatment contains slight changes[10].

CONCLUSION

Although exist a considerable amount of research about COS, there is no standard methodology as a control group, treatment conduct, and measurement of stability. As a conclusion, there is not enough evidence to define an ideal model of treatment and prevention.

However, these results give orthodontists and all dentists not only a deeper guideline for establishing their behaviour towards a successful long-term stability treatment, but also how to have a more assertive approach to the levelling of COS based on each patient's needs.

REFERÊNCIAS

1. Spee FG, Biedenbach MA, Hotz M, Hitchcock HP. The Gliding Path of the Mandible along the Skull. *J Am Dent Assoc* 1980 100(5):670-5.

2. Van Blarcom CW. The glossary of prosthodontic terms. 8. ed. St. Louis: Mosby; 2005.

3. 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 Jun;73(2):193-207.

4. Monson GS. Applied mechanics to the theory of mandibular movements. *Dent Cosmos* 1932 74(1):1039–53.

5. Carter GA, McNamara JA, Jr. Longitudinal dental arch changes in adults. *Am J Orthod Dentofacial Orthop* 1998 Jul;114(1):88-99.

6. 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 Jan;95(1):46-59.

7. Nelson SJ. Wheeler's dental anatomy, physiology and occlusion. 10. ed. Rio de Janeiro: Elsevier; 2015.

8. Al-Amiri HJK, Al-Dabagh DJN. Evaluation of the relationship between curve of Spee and dentofacial morphology in different skeletal patterns. *J Bagh Coll Dentistry* 2015 mar.;27(1):164-8.

9. Marshall SD, Caspersen M, Hardinger RR, Franciscus RG, Aquilino SA, Southard TE. Development of the curve of Spee. *Am J Orthod Dentofacial Orthop* 2008 Sep;134(3):344-52.

10. Lie F, Kuitert R, Zentner A. Post-treatment development of the curve of Spee. *Eur J Orthod* 2006 Jun;28(3):262-8.

11. 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 Aug;110(4):277-81.

12. Taha H. Depth of the curve of Spee in two ancient civilizations [Tese]. Chicago: University of Illinois at Chicago; 2009.

13. 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 Sep;92(1):99-106.

14. Harris EF, Corruccini E. Quantification of dental occlusal variation: a review of methods. *Dent Anthropol* 2008 21(1):1-11.

15. Braun S, Hnat WP, Johnson BE. The curve of Spee revisited. *Am J Orthod Dentofacial Orthop* 1996 Aug;110(2):206-10.

16. Nayar S, Dinakarsamy V, Santhosh S. Evaluation depth of the curve of Spee in class I, class II, and class III malocclusion: A cross sectional study. *J Pharm Bioallied Sci* 2015 Apr;7(Suppl 1):S92-4.

17. 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 Mar;147(3):305-12.

18. Veli I, Ozturk MA, Uysal T. Development of the curve of Spee in Class II subdivision malocclusion: a longitudinal study. *Eur J Orthod* 2015 Aug;37(4):412-7.

19. Shannon KR, Nanda RS. Changes in the curve of Spee with treatment and at 2 years posttreatment. *Am J Orthod Dentofacial Orthop* 2004 May;125(5):589-96.

20. Xu H, Suzuki T, Muronoi M, Ooya K. An evaluation of the curve of Spee in the maxilla and mandible of human permanent healthy dentitions. *J Prosthet Dent* 2004 Dec;92(6):536-9.

21. Burstone CR. Deep overbite correction by intrusion. *Am J Orthod* 1977 Jul;72(1):1-22.

22. Andrews LF. The six keys to normal occlusion. *Am J Orthod* 1972 Sep;62(3):296-309.

23. Carcara S, Preston CB, Jureyda O. The relationship between the curve of spee,relapse, and the Alexander discipline. *Semin Orthod* 2001 7(2):90-9.

24. Al-Buraiki H, Sadowsky C, Schneider B. The effectiveness and long-term stability of overbite correction with incisor intrusion mechanics. *Am J Orthod Dentofacial Orthop* 2005 Jan;127(1):47-55.

25. Dake ML, Sinclair PM. A comparison of the Ricketts and Tweed-type arch leveling techniques. *Am J Orthod Dentofacial Orthop* 1989 Jan;95(1):72-8.

26. Afzal A, Ahmed I. Leveling curve of Spee and its effect on mandibular arch length. *J Coll Physicians Surg Pak* 2006 Nov;16(11):709-11.

27. Bernstein RL, Preston CB, Lampasso J. Leveling the curve of Spee with a continuous archwire technique: a long term cephalometric study. *Am J Orthod Dentofacial Orthop* 2007 Mar;131(3):363-71.

28. 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 Dec;110(6):647-52.

29. Kumar KP, Tamizharasi S. Significance of curve of Spee: An orthodontic review. *J Pharm Bioallied Sci* 2012 Aug;4(Suppl 2):S323-8.

30. Dhiman S. Curve of Spee - from orthodontic perspective. *Indian journal of dentistry* 2015 Oct-Dec;6(4):199-202.

31. De Praeter J, Dermaut L, Martens G, Kuijpers-Jagtman AM. Long-term stability of the leveling of the curve of Spee. *Am J Orthod Dentofacial Orthop* 2002 Mar;121(3):266-72.

32. Nanda R. The differential diagnosis and treatment of excessive overbite. *Dental clinics of North America* 1981 Jan;25(1):69-84.

33. Bench RW, Gugino CF, Hilgers JJ. Bio-progressive therapy, part 2: principles. *J Clin Orthod* 1977 11(10):661-82.

34. Nanda R, Marzban R, Kuhlberg A. The Connecticut Intrusion Arch. *J Clin Orthod* 1998 Dec;32(12):708-15.

35. Begg PR, Kesling PC. The differential force method of orthodontic treatment. *Am J Orthod* 1977 Jan;71(1):1-39.

36. Ricketts RM. Bioprogressive therapy as an answer to orthodontic needs. Part I. *Am J Orthod* 1976 Sep;70(3):241-68.

37. Greig DG. Bioprogressive therapy: overbite reduction with the lower utility arch. *British journal of orthodontics* 1983 Oct;10(4):214-6.

38. Ahmed I, Nazir R, Gul e E, Ahsan T. Influence of malocclusion on the depth of curve of Spee. *JPMA The Journal of the Pakistan Medical Association* 2011 Nov;61(11):1056-9.

39. Harris EF. Root resorption during orthodontic therapy. *Semin Orthod* 2000 6(3):183-94.

40. Pandis N, Polychronopoulou A, Sifakakis I, Makou M, Eliades T. Effects of levelling of the curve of Spee on the proclination of mandibular incisors and expansion of dental arches: a prospective clinical trial. *Australian orthodontic journal* 2010 May;26(1):61-5.

41. Germane N, Staggers JA, Rubenstein L, Revere JT. Arch length considerations due to the curve of Spee: a mathematical model. *Am J Orthod Dentofacial Orthop* 1992 Sep;102(3):251-5.

42. Woods M. A reassessment of space requirements for lower arch leveling. *J Clin Orthod* 1986 Nov;20(11):770-8.

43. Ahammed AR, Ganiger CC, Shetty V, Sunny S, Shetty S, Pawar R, et al. Post-retention Development of Curve of Spee in Pre-adjusted Edgewise Appliance Cases, Its Correlation to Dentoskeletal Parameters: An In vitro Study. *Journal of international oral health : JIOH* 2014 Sep;6(5):31-5.

44. Berg R. Stability of deep overbite correction. *Eur J Orthod* 1983 Feb;5(1):75-83.

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