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Evaluation of skeletal maturity when planning an orthodontic therapy: a comparison between Cervical Vertebral Index (CVM) and Middle Phalanx Maturation Index(MPM). A systematic review.

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Abstract

Evaluation of skeletal maturity is crucial in the planning of an orthodontic treatment plan.

The best results with functional and orthopedic retainers are obtained when the mandibular growth peak is included in the treatment period.

The X-ray of the carpus and the wrist has been till now the most used radiographic method to evaluate skeletal maturity. The latest research in this field has pointed out that also cervical vertebrae can be considered a reliable anatomic reference.

The use of cervical vertebrae as an indicator does not require further exposure to X-ray in addition to lateral cephalometric radiography needed for orthodontic treatment, also for this reason it should be considered a routine procedure in the planning of a orthodontic-functional treatment.

Introduction

It has been clearly demonstrated that skeletal maturity assessment is crucial in planning an orthodontic treatment in a growing subject, as the major effects of functional and orthopedic reteiners occur when the mandibular growth peak is included in the treatment period[1,2].

Over the years, several methods have been implemented that sought, starting from radiological examinations, to highlight the state of tissue growth. Radiographic methods have been proposed that allow evaluation of skeletal maturity on the basis of a single examination.

There are some biological indicators available to evaluate individual skeletal maturity and consequently, for the detection of the pubic height of the mandible. The locations indicated as reliable markers are: the carp, the knee and the cervical vertebrae.

In fact, an ideal radiographic indicator for orthodontic programming should have some characteristics: to have biological validity in describing skeletal maturity and to be effective in detecting the mandibular growth peak[4].

Long-term evaluation of bone age has been made using radiography of the wrist and the hand, based on the radiographic image of the second phalanx of the middle finger of the hand; Recently, the focus switched on the study of the cervical vertebrae, a valid methodology that allows an acceptable diagnostic and therapeutic compromise, even from the point of view of the administration of ionizing radiation, and which is represented by the study of the shape of the cervical vertebrae C2, C3 and C4 that remain included within the latero-lateral teleradiography of the skull, which is required in a routine manner. The shape of the vertebral body and the radiotransparency of its portions provide a snapshot of the degree of ossification.

The aim of this work is to analyze the two different type of growth index as shown in the literature.

Methods

Several orthodontic works have been published in international literature about the analysis of Middle Phalanx Maturation Index(MPM) and Cervical Vertebral Index (CVM)in the planning of an orthodontic-functional treatment.

So the systematic review of literature has been performed on the principal medical databases: PubMed (Medline), Embase and Scopus.

The keywords used were: skeletal maturity, vertebral index, middle phalanx maturation, Â orthodontic treatment.

No restrictions of time and languages have been fixed. The results have been filtered and valued following our eligibility criteria and then organized following the PRISMA method.

The search identified 10,342 abstracts, which were reviewed manually and each article of interest was marked for further review. The full text of the marked

studies was retrieved and studies that satisfied our eligibility criteria were included in this review. At the end only 34 full articles have been selected.

Review

Skeletal maturation (based on Middle Phalanx Maturation index) uses 4 maturation levels found in 6 anatomic locations located in the thumb, in the third finger, in the fifth finger, in the radio. In these 6 sites, there are 11 different indicators (MPMs) covering the entire development period[4].

The first level of maturation concerns the enlargement of epiphysis and itâ€™s a progressive process: epiphysis appears as a small ossification center located centrally at its diaphysis. One recognizes MPM 1 where the center of ossification for the proximal phalanxes of the third finger appears; MPM 2 the center of ossification for the middle phalanx of third finger and MPM 3 the center of ossification for the middle phalanx of the V finger.

The second maturation level is determined by the ossification of the sesamoid. It is a relatively rounded ossification center between the junction of the epiphysis and the diaphysis of the phalanx. It then becomes progressively wider. The presence of this bone is considered as MPM 4. The third level of skeletal maturation is characterized by hardening: the lateral margins of the epiphys begin to flatten and tend towards the diaphysis with an acute angle on the side facing the diaphysis . We will talk about MPM 5 when the phenomenon appears for the last phalanx of the third finger; of MPM 6 for the middle finger of the III finger and of MPM 7 for the average falange of the V finger. The fourth and last maturation level is represented by the fusion of epiphysis and diaphysis.

When the fusion is complete, smooth surface continuity is observed in the junction area. The phenomenon appears in sequence in the distal pharynx of the fingers (MPM 8), in the first phalanx of the fingers (MPM 9), in the middle phalanxes of the fingers (MPM 10) and ultimately in the epiphysis and diaphysis of the radio (MPM11).

The progress of the ossification and growth process causes changes in both the size and shape of the vertebrae. The sequence of these changes was initially studied by Lamparski[5] and subsequently by Maria T, Oâ€™Reilly, Gary J. Yannello[6] in order to identify maturity standards. As skeletal maturation progresses, the forms of the vertebral bodies of C3 and C4 vary: from a nearly cuneiform shape to a rectangular, to a square, and to a shape with the largest side vertical with respect to the horizontal[5]. Vertebral margins appear in the most immature, concave phases in the most advanced phases. The concavities of the lower margins appear in succession for C2, C3 and C4 and become more accentuated with the growth[6].

Regarding the cervical vertebrae, Lamparski identified 6 CVS (Cervical Vertebrae Stages)categories: -CS1: The lower margins of C2, C3 and C4 are flat. The C3 and C4 bodies have trapezoidal shape, with the upper edge flattening from the rear to the front. The mandibular growth peak will take approximately two years after this stage; -CS2: there is a concave on the lower edge of C2. The C3 and C4 bodies still show trapezoidal shape. The mandibular growth peak will occur approximately one year after this stage; -CS3: concavities are present on the lower margins of C2 and C3. The C3 and C4 bodies can be both trapezoidal and rectangular. The mandibular growth peak will occur during the following year this stage; -CS4: concavities are present on the lower margins of C2, C3 and C4. Both the C3 and C4 bodies are of rectangular horizontal shape. The mandibular growth peak occurred approximately one to two years before this stage; -CS5: concavities are present on the lower margins of C2, C3 and C4. One of the C3 and C4 bodies is square-shaped; if it is not squared the body of the other cervical vertebra is in the shape of a horizontal rectangle[5].

The fifth level CS 5 is characterized by the fact that the vertebral bodies have become almost square and the spaces between them are visibly smaller. The concavities are well defined on all six vertebral bodies. The mandibular growth peak has ended at least a year before this stage.

The last stage CS 6 represents maturation: all vertebral bodies have increased in vertical height; all the concavities have deepened. The mandibular growth peak has been completed at least 2 years before this stage.

The increase in mandibular size during this range is greater than what occurs in the previous two intervals. The cervical spine maturation method records a significant deceleration in the mandibular and facial growth S-Gn during the period between phase 4 and stage 5 [1,2].

CS3 is therefore the ideal stage for initiating orthopedic-functional therapy, for example, of Class II as the growth peak will occur in the following year[2,7].

In CS3-4 the interval can be used in routine clinical practice to increase the effectiveness of the treatments that require it including inclined mandibular thrust into

the active treatment period[8,9].

Initial treatment normalizes the skeletal pattern, reduces the duration of permanent denture treatment, leads to overject and overbite reduction, improves functions and achieves more stable results[10,11].

In several studies by Baccetti T[2]., by Lamparski D.G.[5] and by O'Reilly M.T.[6] have shown that the use of cervical vertebrae is as reliable as the carpal. Stage I (CVS1-MPM 1 and 2) corresponds to a phase preceding the puberty growth peak (prepuberal stage); we may have 80-100% residual puberty growth. Stage II, called acceleration (CVS2-MPM 3 and 4), represents the ascending phase of the pubic peak. We will have 65-85% residual growth; the pubic peak begins. The Stage III is the transition stage (CVS 3-MPM 5 and 6), sees 25-65% of residual growth: you are reaching the top of the growth peak. In stage IV, called deceleration (CVS 4-MPM 7 and 8), growth begins to slow, with a residual growth forecast of 10-25%. The V stage is the maturation phase (CVS 5-MPM 9 and 10). We can count on a 5-10% residual growth.

The VI and the last stage, completion (CVS 6-MPM 11), closes the peak of puberty growth; Adolescent growth is completed: there is little or no prospect of residual growth[2,5,6].

Subsequently Baccetti T., Franchi L and McNamara developed a method for evaluating maturation of the most advanced cervical vertebrae. The advantage of this new version of the CVS method is to be able to evaluate on a single cephalogram, through the analysis of cervical vertebrae II, III and IV which are usually visible even when wearing a radiation collar[12].

The new evaluation method recognizes 5 stages instead of 6: CVMS1 to CVMS5. The authors' analytical and cephalometric analysis in this paper has shown that there are no significant differences from a statistical point of view between CVS1 and CVS2. The presence of concavity on the lower edge of the second cervical vertebrae is not a distinctive trait of CVS2 when compared to CVS1; therefore, CVS1 and CVS2 merge into a single CVMS1 level[12].

In a subsequent review by the same authors in order to establish the optimal timing of treatment, it is actually remarked that the appearance of a well-defined concave on the lower margin of C2 indicates the approximation of puberty growth that will take approximately one year after this stage, during the CS3 stage[7].

There is variability in jaw growth, in quantity, in direction, in speedy, in sequence and in time. Especially time factor is an important variable for programming the orthodontic treatment[13].

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Conclusion(s)

Skeletal maturity assessment has been shown to be crucial in dento-facial orthopedy. The major effects of functional and orthopedic retainers are when the mandibular growth peak is included in the treatment period.

The comparison between the carpal index analysis and the evaluation of the vertebral index immediately highlighted the correlation shown in the researches reported in literature and summarized in our study.

Consequently, the vertebral index should be considered a routine procedure in the planning of orthodontic-functional and orthopedic treatment.

References

1. Franchi L., Baccetti T., McNamara J.A. Mandibular growth as related to cervical vertebral maturation and body height. Am J Orthod Dentofacial Orthop 2000;118:335-40.

2. Baccetti T., Franchi L., Toth L.R. et al. Treatment timing for twin block therapy. Am J Orthod Dentofacial Orthop 2000;118:159- 170.

3. Grave K.C. Physiological indicators in orthodontic diagnosis and treatment planning. Aust Orthod J 1978 Feb;5(3):114-122.

4. Fishman L.S. Radiographic evaluation of skeletal maturation; a clinical oriented method based on Hand wrist films. Angle Orthod 1982;52:88-112.

5. Lamparski Don G. Skeletal age assessment utilizing cervical vertebrae. American Journal of Orthodontics April 1975; 67:458-459.

6. O'Reilly MT.., Yanniello G.J. Mandibular growth changes and maturation of cervical vertebrae--a longitudinal cephalometric study. Angle Orthod. 1988 Apr;58(2):179-84.

7. Baccetti T, Franchi L, McNamara JA. The Cervical Vertebrae Maturation Method for the Assesment of Optimal Treatment Timing in Dentofacial Orthopedics. Semin Orthod 2005;11:119-129.

8. Perinetti G., Contardo L., Castaldo A., McNamara J.A. Jr., Franchi L. Diagnostic reliability of the cervical vertebral maturation method and standing height in the identification of the mandibular growth spurt. Angle Orthod. 2016 Jul;86(4):599-609.

9. Ball G., Woodside D., Tompson B., Hunter W.S., Posluns J. Relationship between cervical vertebral maturation and mandibular growth. Am J Orthod Dentofacial Orthop. 2011 May;139(5):e455-61.

10.James R.D. Early protrusion reduction--two phase malocclusion correction: a case report. Am J Orthod Dentofacial Orthop. 1997 Nov;112(5):523-37.

11. O'Brien K., Macfarlane T., Wright J., Conboy F., Appelbe P., Birnie D., Chadwick S., Connolly I., Hammond M., Harradine N., Lewis D., Littlewood S., McDade C., Mitchell L., Murray A., O'Neill J., Sandler J., Read M., Robinson S., Shaw I., Turbill E. Early treatment for Class II malocclusion and perceived improvements in facial profile. Am J Orthod Dentofacial Orthop. 2009 May;135(5):580-5.

12. Baccetti T, Franchi L, McNamara JA. An Improved version of the Cervical Vertebrae Maturation (CVM) Method for the Assesment of Mandibular Growth. Angle Orthod. 2002 Aug;72(4):316-23.

13. Mitani H, Sato K. Comparison of Mandibular growth with other variables during puberty. Angle Orthod 1992 Fall;62(3):217-22.Â