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Different Methods of Measuring Mid-Palatine Suture Maturation in Determining the Timing for Rapid Palatine Expansion: Review

Diferentes Métodos de Medición de la Maduración de la Sutura Palatina Mediana para Determinar el Momento de la Expansión Palatina Rápida: Revisión

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SUMMARY: A historical review of mid-palatal suture maturation (MPSM) is presented to observe the mechanism underlying the evolution of the maturation index set forth for MPSM over time. This review was prepared as a part of a clinical study that investigated the possibility of employing cervical vertebrae maturation (CVM) as a predictor for informing clinicians regarding the maturation status of mid-palatal sutures (MPS). Scientific literature from major indexed databases (Scopus, Medline, PubMed, and Biosis) was included to isolate relevant related papers dating back to the earliest times. The review presents the various methods used to predict various stages of MPSM, with hand wrist radiographs (HWR) and CVM being the most frequently used. For each method, the relevant stages observed were related to the stage of MPSM in both genders, and thus, the necessary intervention (nonsurgical or surgical) for rapid maxillary expansion in constricted maxillary arches can be determined.

KEY WORDS: Midpalatal suture maturation method; Maxillary expansion; Maxillary arch; Palatine sutures; Sex; Interdigitation.

INTRODUCTION

The midpalatine suture (MPS) represents the midline suture on the hard palate, and it extends from the anterior to posterior direction and divides the palate or roof of the mouth into right and left sides. This suture connects to the intermaxillary suture between the central incisors of the maxilla and lies posterior to the incisive canal. The MPS also links the maxillary palatine processes. The interpalatine suture lies perpendicular to the MPS and transverses the palate between the maxillae and palatine bones (Standring, 2021). The cranial suture obliteration commencement is defined as "a continuous process originating from the suture margins" (Carim, 2019). MPS ossification occurs in a variety of forms, including bone spicules in and around bony suture margins, as well as islands of acellular and irregular calcified tissue inside the suture (Korbmacher *et al*., 2007). During development, accelerated interdigitation, which is accompanied by the posterior-to-anterior progression of suture fusion, occurs (Knaup *et al*., 2004). Studies using implants contradicted earlier views, revealing that sutural growth activity lasted considerably longer than early predictions (Björk & Skieller, 1974). The suture assumes several shapes [infancy: Y shape; 10 years: scaly suture; 13 years: short and narrow; adolescence: Sinuous with increased interdigitation; 16–18 years: unified] (Melsen, 1975).

A much earlier debate focused on calcification sites and the absence of fusion, which were later identified as less important than the extent of fusion in an individual (Korbmacher *et al*., 2007). Researchers have extensively studied MPSM, reporting obliteration indexes for individuals

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aged 18–38, 14–71, and 18–63 years (Starnbach *et al*., 1966; Persson & Thilander, 1977). Most studies have concluded that the closure of palatine sutures is influenced by factors other than age, such as vascular, hormonal, genetic, and mechanical factors and local conditions. These variations reiterate the need to develop a method for the evaluation of this suture (Wehrbein & Yildizhan, 2001). The current review will describe the different techniques that are considered a necessary intervention (nonsurgical or surgical) for rapid maxillary expansion in constricted maxillary arches. Also, it will guide the readers about the proper way to select the proper technique according to their patient's needs.

Rapid Maxillary Expansion (RME)

Angell (1860), attempted the first-time rapid maxillary expansion (RME), which involved a screw crossing the mouth roof with ends fixed or anchored at the first and second premolars and activated once daily for 15 days in a 14-year-old patient. Although gradual filling of the bone was reported after lateral separation of MPS, critics rejected the treatment concept, claiming such treatment was anatomically difficult due to the surrounding buttress and nature of the circummaxillary suture (Cryer, 1913). RME piqued the interest of rhinologists in Europe because of its beneficial effects on nasal airflow and blockage (Yuzbasioglu Ertugrul, 2023) This procedure efficiently straightens a deviated nasal septum, alleviates nasal and/or pharyngeal membrane hypertrophy by increasing the nasal airflow, and directly decreases nasal airway resistance as a result of increased nasal dimensions (Wertz, 1968). Nearly a century after the original RME was published; Haas (1961) reintroduced the notion of RME on the basis of a pilot animal study followed by a human case series (45 maxillary/nasal insufficiencies). Researchers noted a large expansion between the MPS, lateral walls of the nasal cavity, and maxillary intermolar distance, and reported a unanimous subjective improvement in nasal breathing. He hypothesized the occurrence of a preliminary maxillary expansion response in the form of transverse alveolar process bending that was gradually followed by its opening at the suture. This condition possibly transpired through the zygomatic buttresses, which caused the two separated maxillary halves to be wedge-shaped, with the apex towards the nasal cavity (Haas, 1970). Researchers scarcely validated the results published in the next half century, adding very little information to previously published findings on RME. RME in monkeys alters sutures located outside of the palate, such as those found in the circumzygomatic, circummaxillary, zygomaticomaxillary, and zygomatico-temporal suture systems (Cleall *et al*., 1965).

Various studies consistently distinguished the skeletal and dental effects of RME in humans (Jafari *et al*., 2003; Provatidis *et al*., 2008). Recent research has compared the effects of RME with those of slow maxillary expansion (SME). According to the most recent systematic review, SME shows superiority to RME in terms of the expansion of the molar region of the maxillary arch (Zhou *et al*., 2014); nevertheless, this study cited nonrandomized controlled trials, that were based on Michigan Growth Studies, i.e., historical data (McNamara Jr. *et al*., 2003).

Indications and clinical considerations of RME

RME refers to the treatment of unilateral or bilateral posterior cross bites caused by a maxillary arch transverse deficiency. Skeletal and dental conditions, or their combination, may be the underlying cause of such conditions (Bishara & Staley, 1987). In addition, RME can be utilised to address narrow maxillary arches, mild congestion, and cleft palates with or without cleft lips before secondary grafting of the alveolar bone (Haas, 1980; Bishara & Staley, 1987). If there is a transverse disparity of at least 4 mm between the maxillary and mandibular teeth, we recommend RME. We can expect a more positive prognosis in terms of RME if more teeth contribute to the cross bite. For maxillary posteriors with a buccally inclined angulation, we do not employ traditional RME because it may exaggerate the tipping of the posterior teeth (Agarwal & Mathur, 2010). RME assists in directing posterior tooth development towards proper occlusion, which thereby allows the vertical closure of jaws to prevent any functional shifts (centric relation) and the development of any type of temporomandibular joint disorder (Bell, 1982). RME may be beneficial in the treatment of patients suffering from a palatally impacted canine (Ballanti *et al*., 2009). In conjunction with protraction headgear, RME is used to treat skeletal class III conditions with a high probability of the maxilla moving forward (Baik, 1995). Intervention with RME improved nasal breathing in patients with nasal blockage (obligatory mouth breathing) and restricted nasal passage opening (conchae compressed against the nasal septum) (Haas, 1980). Symptomatic relief following RME has been attributed to the orthopedic effect of the restored normal function of the pharyngeal ostia of the eustachian tube (Gurel *et al*., 2010) and the decreased incidence of recurrent serous otitis media after the procedure (Gray, 1975). RME has also been linked to better hearing in kids (Ceylan *et al*., 1996), who have nocturnal enuresis (a condition in which 5–6-year-olds wet the bed more than twice a month) (Rushton, 1989) and sometimes relief from primary headache symptoms (Farronato *et al*., 2008).

An average-sized dentition can comfortably fit into a 36–39 mm-wide maxillary arch between the first and second permanent maxillary molars without crowding or diastema. Arches measuring less than 31 mm in diameter may be incapable of supporting the entire dentition, which necessitates orthopaedic intervention. Crowding, which is one of the most common occlusal changes in orthodontic consultations, is caused by a discrepancy between tooth size and bone base. This malocclusion develops largely due to transverse maxillary deficiency and sagittal asymmetry, which are widely established etiological reasons (McNamara, 2006; Mosleh *et al*., 2015).

RME also substantially influences the maxillary-mandibular relationship while improving the ANB angle by one or two degrees (Guest *et al*., 2010). Its long-term effects on the MPS involve MPS recalcification after suture opening; however, data show discordance when determining whether the MPS opening is parallel or triangular (Liu *et al*., 2015). Researchers have also reported the negative impacts of both surgical and nonsurgical RME. Researchers have reported that surgical RME results in decreased buccal bone plate thickness, remarkable bone dehiscence, fenestration, root resorption, reduced alveolar-bone-crest-level alveolar bending, gingival recession, and chronic occlusal balancing interferences (Morris *et al*., 2017; Sendyk *et al*., 2018). Nonsurgical RME is commonly associated with buccal tipping of the posterior teeth, widening and flattening of the palate (in rhesus monkeys), and tipping of the anchor tooth (Cleall *et al*., 1965; Bishara & Staley, 1987). The RME force application at anchored teeth results in undesirable buccal tipping (Sendyk *et al*., 2018).

Methods for investigating MPSM

Wertz & Dreskin (1977) studied lateral and frontal cephalometric roentgenograms of deciduous, mixed, teenage, and adult teeth to provide a general statement on the dental and skeletal changes resulting from suture opening. Wehrbein & Yildizhan (2001), evaluated the MPS on occlusal radiographs and compared the suture morphology, mean suture width (MSW), and degree of suture closure on the stained section. They concluded that a radiologically visible MPS corresponded histologically to a predominantly straight-running oronasal suture and failed to show a radiologically invisible MPS as the histological equivalent of a fused or closed suture. Knaup *et al*. (2004), conducted histomorphometry analysis of age-related morphological differences (local topography) in autopsy tissue blocks (aged 18–63 years) and concluded that MPS ossification was not a feasible explanation for the high transversal resistance observed during RME in younger subjects (≤25 years).

Korbmacher *et al*. (2007), evaluated MPS morphology (28 human palatal specimens) and reported substantial interindividual and intrasuture variations. Xiao *et al*. (2022), used occlusal radiographs and histopathology to determine the status of MPS in 20 human palates (>70 years). In all subjects, anterior palatal suture ossification was discovered, but not in the posterior third, which consisted of connective tissue. The use of ultrasonography to develop qualitative ossification assessment following surgically assisted RME (SARME) provides precise information on bone fill and has the advantage of being a noninvasive and economic technique (Hoang *et al*., 2024). Three-dimensional laser scanning with reconstruction software was used directly on subjects (6–14 years) to determine the palatal height increase in all variables without any significance in sexual dimorphism (Stern *et al*., 2020). Franchi *et al*. (2010), conducted assessments of the MPSD via low-dose CBCT prior to RME, at the termination of active RME, and at the six-month post-retention period. They concluded that active opening of MPS via RME significantly decreased suture density among prepubertal subjects. Suture density after 6 months of retention post-RME determined the reorganization of MPS and demonstrated values similar to those of pretreatment ones.

Angelieri *et al*. (2013), studied sexual dimorphism in MPS fusion, with females maturing earlier than males. They analysed MPSM in late adolescent and young adult patients after two years and observed the uncertain prognosis of RME (Angelieri *et al*., 2015). Conventional RME or SARME for late adolescents and young adults is based on the individual assessment of MPSM on the CBCT, which serves as a basis for decision making. A method for individual MPS evaluation using CBCT was considered, and it involved the observation of suture images at various stages. Throughout treatment, RME exhibited less resistance, and a maximum skeletal effect was observed in Stages A and B than in Stage C; meanwhile, ossification areas were observed along the suture of patients in Stages D and E, where the surgically assisted expansion was best showcased as partial or total MPS fusion (Angelieri *et al*., 2016) (Fig. 1).

Gueutier *et al*. (2016), used multislice CT scans to detect resistance areas in MPS in a study on fresh corpses (age range: 70–86 years) and concluded a statistical difference between two subgroups of MSW; this finding indicates that multislice CT can be used for the evaluation of MPS width. Kwak *et al*. (2016), evaluated the correlation of fractal patterning to the ossification of MPS (via CBCT) and determined the feasibility of using MPS fractal analysis in the assessment of MPSM. They concluded that the fractal dimension had a strong negative correlation with MPSM. They attributed the effectiveness of fractal analysis to its objective quantitative method. Tonello *et al*. (2017), studied individuals aged 11–15 years and evaluated MPSM stages via CBCT. They observed the dominance of stage C in

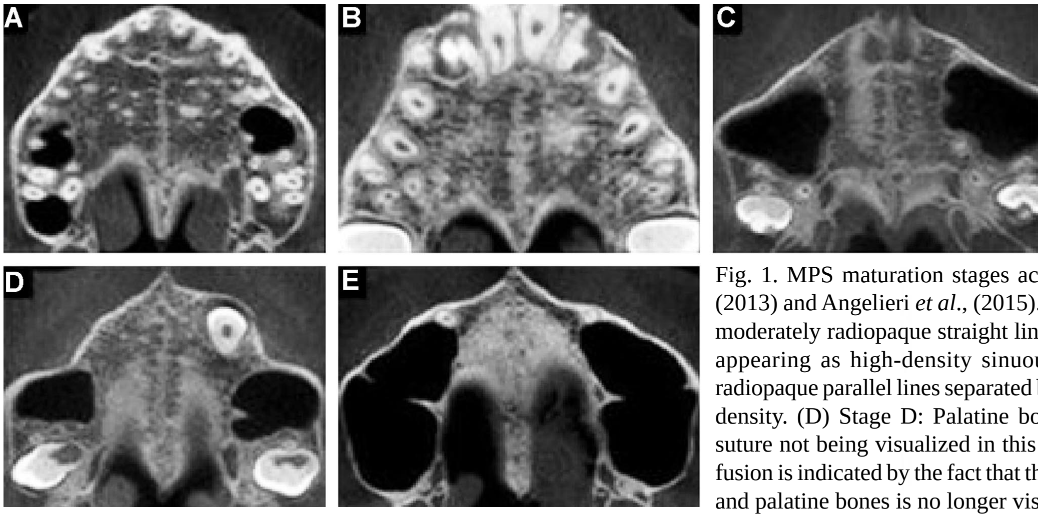

Fig. 1. MPS maturation stages according to Angelieri *et al*., (2013) and Angelieri *et al*., (2015). A) Stage A: MPS seen as a moderately radiopaque straight line. (B) Stage B: MPS suture appearing as high-density sinuous line. (C) Stage C: Two radiopaque parallel lines separated by areas of low radiographic density. (D) Stage D: Palatine bones more radiopaque with suture not being visualized in this region. (E) Stage E: suture fusion is indicated by the fact that the suture along the maxillary and palatine bones is no longer visible. stage E.

MPSM and suggested conventional nonsurgical RME for patients over 15 years old; they also concluded that nonsurgical RME for patients over 15 years old is a satisfactory prognosis when the assessment of suture status indicates stage C. The majority of the subjects between 16 and 20 years reported stages C, E, and D, which accounted for 91.9 % of the total. According to Angelieri *et al*. (2013), the method for individual evaluation of MPSM reveals potential reliability and reproducibility but is not completely reliable for routine clinical applications.

Cone beam computed tomography (CBCT). With the use of study models or standard radiographs, previous papers have evaluated changes in the maxillary transverse dimensions. Conventional radiographs have limited capability to distinguish dentoalveolar and orthopaedic effects. The limitations involve magnification of the anatomical region closest to the X-ray source, distortion, and superimposition of nearby structures. CBCT and other three-dimensional (3D) imaging techniques have been proposed to overcome several drawbacks associated with conventional radiography and other methods (Miner *et al*., 2012). CBCT employs a detector-directed cone-shaped X-ray beam, with the source and detector housed in a rotatory gantry, to produce serial 2D images. Complex algorithms recreate the original acquisition to generate a 3D datas*et al*ong the x, y, and z axes, which is necessary for volumetric axial, coronal, and sagittal analysis (Miles, 2008). As a high-resolution scanning technique, CBCT enables the accurate representation of MPS in vivo with minimal distortion and/ or overlapping of structure. Thus, this method is an indispensable instrument for the assessment of MPSM, which will aid in the selection between tooth-anchored RME, MARPE, and SARME as a treatment option (Liu *et al*., 2015).

The As-Low-As-Reasonably-Achievable Principle and Sedentex CT guidelines must always guide radiography due to the attributable lifetime radiation risk (Carim, 2019). Effective radiation dose (RD) by CBCT [20–100 mSv] surpasses those of conventional 2D panoramic radiograph [RD = 3–5 mSv], cephalometric radiograph [RD = 3–5 mSv], and a full mouth series [RD = 12–58 mSv] (Abdelkarim, 2019). The results are affected by a wide range of factors, including scan time, CBCT imaging unit, field of view, milliampere setting, voxel size, peak kilovoltage, and sensor sensitivity. CBCT is recommended when either the limitations of 2D imaging impair diagnosis and treatment plans or when the benefits outweigh the risks (Spin-Neto *et al*., 2013).

Cervical vertebrae maturation (CVM) index

Lateral cephalometric radiographs that scan cranial and dentofacial structures have the advantage of head positioning in a reproducible, similar, standardized position with the assistance of a cephalostat. This enables the comparison of various radiographs of different individuals or those of the same individuals at varied intervals without considerable error incorporated in the radiographs (Proffit *et al*., 2012). The first four cervical vertebrae (CV) in the spinal column that represent the relevant CV are easily visualized on cephalograms (Fig. 2). Recording of the shape and dimensions of the CV during the period of growth has been reported as early as 1928 (Todd & Pyle, 1928). Lamparski (1972) introduced a popular method of CVM standard used for either sex; this method uses a six-grade system used to grade annual changes in the shape and size of the five CVs (C2 to C6). The modified maturational index introduced by Hassel & Farman (1995), for the CV included radiographic analysis of the first four CVs and Fishman's HWR, which is divided in detail into six categories, namely, acceleration, initiation, deceleration, transition, completion, and maturation. A high correlation was reported between CVM and hand-wrist maturity (HWM). Baccetti *et al*. (2002), modified the staging system by naming a five-stage system from CVM stages I to V between CVM stages II and III, mandibular growth peaked, with a subsequent observation for CVM stage V occurring two years later. Baccetti *et al*. (2005), introduced a further improvised CVM method [Fig. 3 cervical stage (CS 1 to 6)]. Three CVs (C2, C3, and C4) were evaluated using the six CVM stages, from cervical stage I to cervical stage VI. The first and second cervical stages were prepeak stages, and the fifth and sixth cervical stages were post-peak growth spurt stages. Between the third and fourth cervical stages, the mandibular growth peak appeared. Cervical stage six occurred at least two years following the growth peak. Franchi *et al*. (2000), proved that the CV maturity stage method is valid for estimating skeletal maturity and pubertal growth peak identification. A study on Japanese females found that CV bone age represents skeletal maturation and can be considered the most acceptable and reliable method for estimating skeletal maturity (Mito *et al*., 2002).

Fig. 2. Exemplary Lateral cephalometric radiograph (Proffit *et al*., 2012).

In addition, studies on Turkish (Uysal *et al*., 2006) and southern Chinese (Wong *et al*., 2009) populations further established the validity of the CVM method, which began to be utilized widely for the evaluation of skeletal age due to its simplicity, objectivity, and repeatability, given that lateral cephalograms are available for all patients as a diagnostic record. Anatomical changes and dimensional measurements of CV for the determination of skeletal maturity in orthodontic diagnosis and treatment planning are considered an alternative method to HWR, with the chief advantage of decreasing the subject's exposure to RD (Altan *et al*., 2012). Visual evaluation of the CVM stages on cephalometric radiographs is reproducible and accurate to a reasonable level between populations. Cericato *et al*. (2015), published a systematic review and meta-analysis regarding CVM validity and the possibility of using the CV method instead of the HWR method. They confirmed that the CVM stages showed superior and appropriate reliability and can be an alternative to the HWR method for the establishment of the peak of the pubertal growth spurt. Durka-Zajac *et al*. (2016), stated that for bone age estimation, the CVM method proposed by Baccetti *et al*. (2005), is the most suitable for the evaluation of bone age. This method can serve as a substitute for the HWR method due to the decrease in radiation to the patient and the short examination period.

Correlation between MPSM and CVM

Revelo & Fishman (1994), used occlusal radiographs and HWRs and evaluated the correlation between the radiographic examination and the degree of MPSM. They revealed a significant correlation between skeletal maturational development and the onset of ossification of MPS but a poor correlation with the course of suture ossification, which rendered the quantitative determination of the degree of ossification in the region impossible. Haghanifar *et al*. (2017), evaluated the ossification of MPS using a maxillary radiograph (cross-section occlusal view) and CBCT scans of the hard palate in the axial direction. The findings showed a link between the percentage of ossification, cervical vertebral maturation, and MPSM stages in subjects in groups I (ages 8.1 to 16.1) and II (16.1 to 25.1 years), which was based on their chronological age. A lower statistical significance was observed in the ossification of MPS compared with the cross-sectional maxillary occlusal radiograph. Angelieri *et al*. (2015), analyzed the diagnostic performance of the CVM method for the accurate estimation of MPSM stages and observed that prepubertal CVM stages (CS1 and CS2) can be used as reliable indicators for MPSM stages A and B; in addition, CS3 in CVM indicated a reliable stage C during MPSM, and CS5 in CVM means that the fusion of MPS already occurred partially or totally (stages D and E in MPSM). For post pubertal patients (CS4 and CS5), individual assessment (MPS with CBCT) should be undertaken given that 13.5 % of patients at CS5 can be presumably treated with conventional RME; in addition, if the CVM stage cannot be assessed, age may be a viable alternative for the prediction of some MPS stages (particularly the early stages).

Fig. 3. Exemplary lateral radiographic view showing various cervical vertebrae maturation (CVM) stages. (CS – cervical stage) CS (1) – C2-C4 have flat lower margins. C3 and C4 have trapezoid-shaped bodies (the superior margin of the vertebral body is tapered from posterior to anterior). In 2 years, mandibular growth will peak. CS (2) – C2's lower edge is concave (in four of five cases, with the remaining subjects still showing a cervical stage 1). C3 and C4 have trapezoid-shaped bodies. After 1- year, mandibular growth peaks; CS (3) – C2 and C3 have lower concavities. C3 and C4 have trapezoid or horizontal rectangular bodies. After one year of this stage, mandibular growth peaks; CS (4) – Lower margins of C2, C3, and C4 now have concavities. C3 and C4 have horizontal rectangular bodies. 1 or 2 years before this stage, mandibular growth peaked; CS (5) – Lower margins of C2, C3, and C4 have concavities. At least one of C3 and C4 have square bodies. The other cervical vertebra is rectangular if not squared. Mandibular growth peak ended 1 year earlier; CS (6) – Lower C2, C3, and C4 still have concavities. At least one of C3 and C4 have rectangular vertical bodies. If not rectangular vertical, the other cervical vertebra is square. Mandibular growth peaked 2 years earlier.

Jang *et al*. (2016), determined MPSM and identified morphologies on CBCT images and their relationships with other developmental age indices. Bone age was assessed using HWM and CVM; dental age (Hellman's index), chronological age, and sex were evaluated simultaneously. The results revealed that the assessment methods of maturation suggested a strong correlation and high association with the assessment of MPSM. Titus *et al*. (2021), tested the novel measurement of MPSD ratio and concluded that such a variable may potentially be used as a clinical predictor of skeletal response to RME. Moreover, chronological age, CVM, and stages of MPS cannot be deemed useful parameters for the prediction of the skeletal effect of RME. Kim *et al*. (2018), and Gonzálvez Moreno *et al*. (2022), observed significant relationships between morphological stages and bone density of MPS while assessing ossification and MPSM via CBCT. Atik *et al*. (2018), evaluated the stages of MPS in patients older than 15 years and determined the correlation among the stages of MPSM, age, and CVM. Their findings demonstrated that neither CVM nor chronological age serve as a useful method for identifying the MPSM stages in patients aged 15-30. Samra & Hadad (2018), evaluated the relationship between MPSD and CVM and investigated whether CVM can aid in the prediction of MPS development status. They observed that the density of MPS increased with skeletal maturation and increased prominently after puberty, which lowered the skeletal effects of RME. The diversity of bone density in some maturation groups can be an explanation for the variation in RME success in adults.

CONCLUSION

Various methods have been proposed for diagnosis and treatment of MPSM at different stages. Most of those ways and techniques are considered desirable for nonsurgical rapid maxillary expansion in both sexes. Clinicians should be cautious of the routine application of such methods and be aware of the extensive training and calibration program that must be performed prior.

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RESUMEN: Se presenta una revisión histórica de la maduración de la sutura palatina mediana (MSPM) para observar el mecanismo subyacente a la evolución del índice de maduración establecido para la MSPM a lo largo del tiempo. Esta revisión se preparó como parte de un estudio clínico que investigó la posibilidad de emplear la maduración de las vértebras cervicales (MVC) como predictor para informar a los médicos sobre el estado de maduración de las suturas palatinas medianas (MSPM). Se incluyó la literatura científica de las principales bases de datos indexadas (Scopus, Medline, PubMed y

Table I. Description of CVM stages based on (Baccetti *et al*., 2005) methods.

CV Stage	Description	Radiographic representatior
Cervical stage 1 (CS1)	C2-C4 have flat lower borders. C3 and C4 have trapezoid-shaped bodies (the superior border of the vertebral body is tapered from posterior to anterior). In 2 years, mandibular growth will peak.	
Cervical stage 2 (CS2)	C2's lower edge is concave (in four of five cases, with the remaining subjects still showing a cervical stage 1). C3 and C4 have trapezoid-shaped bodies. After 1-year, mandibular growth peaks.	
Cervical stage 3 (CS3)	C2 and C3 have lower concavities. C3 and C4 have trapezoid or horizontal rectangular bodies. After one year of this stage, mandibular growth peaks.	
Cervical stage 4 (CS4)	Lower borders of C2, C3, and C4 now have concavities. C3 and C4 have horizontal rectangular bodies. 1 or 2 years before this stage, mandibular growth peaked.	
Cervical stage 5 (CS5)	Lower borders of C2, C3, and C4 have concavities. At least one of C3 and C4 have square bodies. The other cervical vertebra is rectangular if not squared. Mandibular growth peak ended 1 year earlier.	 cs5
Cervical stage 6 (CS6)	Lower C2, C3, and C4 still have concavities. At least one of C3 and C4 have rectangular vertical bodies. If not rectangular vertical, the other cervical vertebra is square. Mandibular growth peaked 2 years earlier.	 cs6

Biosis) para aislar los artículos relacionados relevantes que datan de los tiempos más remotos. La revisión presenta los diversos métodos utilizados para predecir las distintas etapas de MSPM, siendo las radiografías de mano y muñeca y MVC las más utilizadas. Para cada método, las etapas relevantes observadas en ambos sexos se relacionaron con la etapa de MSPM y, por lo tanto, se puede determinar la intervención necesaria (no quirúrgica o quirúrgica) para la expansión maxilar rápida en arcos maxilares constreñidos.

PALABRAS CLAVE: Método de maduración de la sutura mediopalatina; Expansión maxilar; Arco maxilar; Suturas palatinas; Sexo; Interdigitación.

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