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Short Communication

Assessment of Palatine Suture Maturation by "Black Bone" RMI- A Preliminary Feasibility Study

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Abstract

Objectives: To determine the potential of "Black Bone" MRI as an alternative to CT in the maturation parameters of the palatine suture and identify the optimal time to perform orthodontic palatal expansion.

Methods: One patient aged 8.3 years underwent "Black Bone" MRI. Palatine suture was evaluated by using a similar method to access suture fusion stages in CTBC images adapted to "Black Bone" MRI.

Results: Patient palatine suture was consistently identified on "Black Bone" MRI as areas with different signal intensity similar to the maturation stage A founded in tomographies of patients at the same age.

Discussion: "Black Bone" MRI should be considered as an alternative to CTBC to assess the maturation of medial palatine suture for orthodontic purposes.

Conclusion: "Black Bone" MRI has considerable clinical potential as a non-ionising alternative to CT in the assessment of the medial palatine suture.

Keywords: Magnetic Resonance Imaging; Radiation Protection; Dentofacial Deformities; Malocclusion

Key Points

- Patient sutures appear with increased signal intensity in "Black Bone" MRI easily distinguished from the signal void of the cranial bone. The suture could be followed throughout their course.
- Clearly different stages of suture fusion can be identified according to the age.
- No ionising method can be used to find the optimal time to perform orthodontic palatal expansion. Overall, "Black Bone" MRI offered an improved method of evaluation and provides a potential non-ionizing alternative to CT.

Introduction

Transverse maxillary deficiency is a common orthodontic problem and is often accompanied by unilateral or bilateral posterior crossbite and dental crowding [1]. The best time to do the palatal expansion is in the anterior phase or during adolescence [2-7], since after this phase there may be a need for a complementary surgery [8] to weaken the bony bases, allowing the expansion.

The most common approach is the use of a tooth-supported expander, with or without acrylic [9,10]. Some undesirable effects related to the age are: exaggerated inclination of the posterior teeth and lack of expansion of the middle third of the face as a result of the palatine and maxillary sutures ossification [3].

The ossification of the medial palatine suture starts from the palatine part and extends to the incisive foramen showing histological and radiographic changes [11]. The knowledge of the maturation stage of the medial palatine suture has great importance for the success of the palatine disjunction so that the verification of local conditions can only be done by imaging methods.

The ideal pattern for studying the effects of palatine disjunction is concomitant computed tomography, since the morphological aspects and even the volume of the structures before and after the procedure can be evaluated [12,13].

Recently, a method of prognosis of palatal disjunction was described by the evaluation of ossification stages in concomitant computed tomography scans that help predict the success of this operation [14].

Despite the practicality and lower costs, the use of ionizing radiation in tomographies has been questioned by orthodontists [15] and the possibility of evaluating images of the ossification of the median palatine suture using nuclear magnetic resonance seems a promising field.

The soft part of the sutures is formed by a layer of vascularized connective tissue that diverges from the calcified cortical of the bones that compose it. The relaxation times of these tissues in T1 and T2 produce the necessary contrast in the generated images [16], through the off-line post-processing in workstation of the previously obtained images of these patients.

Recently, a new regimen of examination has been described [17] in order to shorten the time and accentuate the contrast between skull sutures and other structures [18], called ´Black Bone" RMI.

The regimen in question allows the suppression of the sign of fat and water present in soft tissues and accentuates the visualization of the cortical bone, which appears in black. In addition, it is not necessary to inject radiological contrast that is invasive and can be dangerous for some patients.

This method allows the visualization of points used in radiographic cephalometry [19] and allows the obtaining of 2D and 3D images with ease of access to the cranial sutures [20] and the acquisition time is smaller than the conventional resonance (around 4 minutes), which is beneficial to the patient, especially in children.

Regarding Otorhinolaryngology, the treatment of transverse deficiency seems to have favorable effects in several aspects. Improvement in oral breathing [20] and head posture [21] was verified in children treated with this methodology.

Improvement in hearing loss was verified in children subject to expansion by the influence on the muscular function of the auditory tube and improvement in the mobility of the tympanic membrane [22]. In addition, other general health benefits of children are related to treatment with palatal expansion, such as improvement of sleep quality and nocturnal enuresis [23-25].

Palatine atresia was present in 72.9% of patients who presented episodes considered to be a risk of death by parents or guardians related to the combination of apnea, color change, muscle tone, choking or coughing when compared to another group of children who did not had these episodes [26-28].

Since the treatment of transverse constriction depends on the maturation stage of the median palatine suture, which in turn may contribute to otorhinolaryngological treatment, it seems important to establish previously the best occasion for its application.

For this reason we propose a method of evaluation of the median palatine suture without the use of ionizing radiation that can be used to establish the best moment for the treatment of expansion especially in circumpubertal individuals.

The purpose of this research is to evaluate the possibility of using "Black Bone" magnetic resonance imaging for the planning of the palatal disjunction procedure without the use of ionizing radiation from CT.

Materials and Method

Patient Ethical approval was granted by the Brazil Educational Association (Associação Educativa do Brasil) Research Ethics Committee (Sao Paulo, Brazil) 48278115.8.0000.5141, for MRI examination in patients aged five years and older in whom conventional face/cranial base RMI were needed for other problems than diseases that could interfere in the sutural or bone maturation. Written informed consent from the participants and/or their parents was obtained. Patients who had previously undergone surgery, had completed orthodontic treatment or had fixed orthodontic appliances were excluded. For this time, one volunteer with age 8.3, was selected by age and sex to match the most approximated mean according to Angelieri., *et al* [1].

"Black Bone Imaging was acquired on a 1.5T magnet resonance machine (Philips) with image acquisition centered on the middle axial structures to permit visualization of the palatine suture. According to the following protocol:

Repetition time: 8.6 ms, Echo Time: 4.2 ms, Flip Angle: 5º, Scan FOV: 24 cm, Phase Encode: 256, Frequency Encode: 256, Receive Bandwidth: 31.25, ZIP: 2,512, NEX: 2, ETL: 1, Slice width: 2.4 mm, Space between slices: 1,2 mm.

The mean acquisition time in the conventional in the "Black Bone" protocol was 3.5 minutes.

Head orientation: Natural head position in all 3 planes of space with the image analysis software cursor positioned at the patient´s midsagittal plane in both coronal and axial views, the long axis of the palate horizontal in the sagittal view (Figure 1).

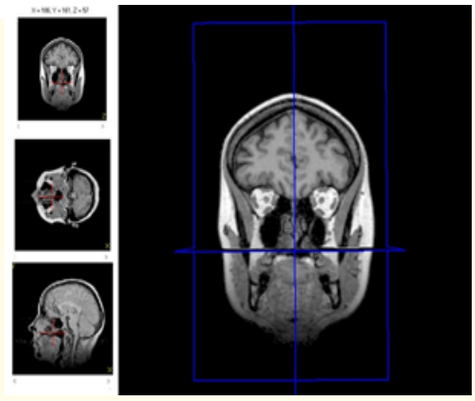

Figure 1: Head position in all 3 planes of space with the image analysis software cursor positioned at the patient´s midsagittal plane in both coronal and axial views, the long axis of the palate horizontal in the sagittal view.

The cross-sectional slice was used for sutural assessment after placing the horizontal line of the software along the palate.

Positioning parameters were used to evaluate the axial sections of the maxillary bones, palatine bones and the medial palatine suture.

Through the software Radiant DICOM viewer (Mexidant, Poland) the DICOM files were processed for adjusting brightness, contrast and zoom and exported to the Jpeg file format.

The images were evaluated by three researchers (RCR, NJCR, BCR) after a calibration for the parameters of interest and the images selected to illustrate the maturation phases. For this purpose a flowchart adapted from Angelieri., *et al.* [1] was used, as can be seen below.

Results

For the three researchers midpalatal suture could be seen as a regular shaped line of increased signal intensity on "Black Bone" MRI, distinct from the cranial bone, from the incisive forame through the palatine-maxillary suture. No interdigitation between both sides has been found, similar to the stage A of Angelieri., *et al.* [1] (Figure 2).

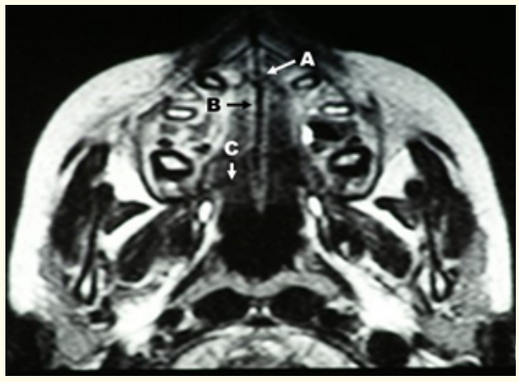

Figure 2: A: incisive foramen, B: regular shaped line of increased signal intensity at the vascularized part of the suture, C: palatine-maxillary suture.

Conclusion

The Black Bone RMI protocol offers an advantage in relation to the time of acquisition of the conventional protocol and it is not intended to the emission of ionizing radiation from the computed tomography, being a viable alternative to establish the best alternative for the orthodontic expansion procedure of the palate. Based on this preliminary study we are known continuing the research to a large patients in different ages and sexes to validate this method.

Conflict of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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