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Comparison Between 3d and 2d Images in Diagnosis and Treatment of Facial Asymmetries: a Systematic Review

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Abstract

PA cephalogram has been used in orthodontic for the treatment of asymmetry[1,2]. The PA cephalogram provides information useful for facial asymmetric evaluation and for evaluation of the craniofacial skeleton and dentoalveolar structures in frontal plane[3]. We know how PA cephalogram is a projection of a three-dimensional skeletal structures, into a two-dimensional surface of the film. Therefore, this transposition of images can lead to enlargement, distortion and projection error. Sometimes, PA doesn't give accurate information, particularly regarding deviation of the chin. Some studies have proposed the combined use of more radiographic exams Postero-Anterior (PA), Laterlo-lateral (LL), and submento-vertex views for 3D evaluation of the maxillofacial complex.[4] However, 2D radiographs have the limitations of enlarging and distorting the image, and this can lead to misdiagnosis.[5,6]

Cephalometric measurements on PA are subject to distortion, so it should be use just to compare right and left sides in a qualitative way more than quantitatively way.[7]

Because quantitative measurement is a key element in the diagnosis of asymmetry, a 3D analysis with 2D radiographs obviously cannot be always used.

Aim of this works is to evaluate the statement of art about the use of CBCT, in orthodontics, and in the diagnosis, treatment planning of the asymmetries.

Introduction

LIMITATIONS OF PA CEPHALOGRAM

The limitation that we considered is the error due to identify the reference point. It is link to the identification of the landmarks, there are many factors that may affect the evaluation: the radiographic image density and clarity, and the overlapping of the soft tissues, individual variations in skeletal structures, and the viewer's experience play an essential role. Altoutght, this margin of error is due to a small area.[8]

From these observations, the researchers assessed how the inclusion of studies within a margin of error calculated through repeated measurements becomes superfluous especially if the observations are performed by the same operator.[9]

A more important error it is when there is a rotation of the head, an incorrectly projection that affects the validity of PA. The rotation of the head causes an artificial distortion for which the structures in vertical and in the horizontal ones have an altered dimensions and thus the position of reference points. Greater is the distance, greater will be the influence that the rotation of the head has on the radiographic distortion. In particular, the points that are located forward respect to the axis of rotation will be arranged in the direction of rotation of the head, on the contrary, the seats points located posteriorly to the axis displaced itself in the opposite direction. The rotation through the plan anteroposterior goes to influence more the vertically points. The rotation on the vertical axis, influences the horizontal measures. The variations in the inclination of the head measurement around the vertical axis, changes significantly affect points nearest the midline as the mention and Nasion[10]. Studies have viewed as 5° difference in orientation of the head considering inclinations top to bottom or left to right are not so influential goodness of radiography, and as validated by studies Gaìhafari[11] et al. these can be acceptable since rejoined the range of +/- 5°. Although we must considere how, the mandibular height was influenced by well 3 mm with only 2° of rotation. Finally, it is also considered how a higher degree of asymmetry of the ears can significantly influence, because there will be a change in the positionin of the head in the cephalostat, and therefore in this case, the ear plugs, should be removed and try to position the patient with the median sagittal line identified clinically perpendicular to the floor and to the radiographic film. Moreover, the errors resulting from magnification can confuse the analysis of PA; The distortion level decreases for any facilities that are closer to the film, but it is also variable in the different considered plans. The landmarks are not placed at the same distance from the focal range, each point will be affected differently. For example, the mandibular width will be subject to twice so increased by the distortion

with respect to the jaw width, and this shows how the width of the two jaws can have considerable discrepancies.

Nowadays 3Dimensional images has been used for a reliable diagnosis of asymmetries. If at first the use of 3D imgaes, was doing with a spiral CT, and the use of this exam was limited for problems links to the patient's radiation dose, now with the use of CBCT there significant reduction in radiation dose. Moreover, CBCT has been shown to produce a 1-to1 image that are very reliable for the detection of asymmetries, because they can offer a precisely quantitative dimension of the asymmetry's degree[12,13]. A lot type of studies in literature examined how CBCT imaging could be very useful for the assessment of asymmetry.[14]

Materials and Methods

Nowadays, various studies have been published on international literature about the use of CBCT image and underlined how that could be more reliable and more accurate to diagnose facial deformities. The CBCT have represented a good alternative to standards radiographic images. So a detached research of international literature has been performed using the principal medical databases: PubMed (Medline), Lilacs and Scopus. The keywords used were: CBCT; 3D IMAGES, ASYMMETRIES, to identify all articles reporting on the topic till October 2016.

Review

3D IMAGES RELIABILITY IN ASYMMETRIES DETECTION.

Many studies underlined how an asymmetrical face is common, the first of all is the work of Proffit[15], which detected in a retrospective survey that the 34 per cent of 1460 patients evaluated by the dentofacial clinic at the university of North Carolina were found to have clinically apparent facial asymmetry. These findings are important for the clinician practice because asymmetry must be identified and planned for print to initiating treatment, thus them underlined the need to have an accuracy detection of the maxillofacial complex.

A study of Sanders[16], occurred how minor asymmetries exist and is a common finding in the normal human craniofacial complex. This study takes in exams the benefits that the use of 3d images could carry on detection of facial asymmetries. It analyzed thirty consecutive Class I patients by three-dimensional cone-beam computed tomography (CBCT). The findings underlined how asymmetries are present in all planes by CBCT analysis in a normal, adolescent population. Moreover, their research underlined how the craniofacial structures in order to work in a correct and functional way, have a natural compensatory mechanism, that control size and shape of the muscle that modify the above soft tissue and can lead to a misdiagnosis of a substructural skeletal asymmetry. This is in agreement with what is stated in the literature, as reported in the work of Rhodes[17] and Farkas[18], which show that a level of mild skeletal asymmetry is often masked by the soft tissues.

ACCURACY IN REPRODUCING ANATOMIC STRUCTURE

CBCT modality has allowed better discernment between overlapping structures and increasing to recognize anatomical structures and landmarks. The use of a 3D system identifying landmarks in a more precisely, such as the ANS, PNS, basion, porion, orbitale, condylion and L1 root tip, that were traditionally more difficult to locate in 2D. In addition, 3D technology would be more useful for precise measurements that are important in evaluating growth change or treatment effects. Another study of the precision of CBCT, is the one of Lagravere et al.[19] that compared the accuracy of measurement of metallic landmarks placed in a synthetically mandible made both on the CBCT and with CMM (coordinate measuring machine), that is considered a gold standard method, they concluded that 3D images on CBCT have a 1-to-1 ratio with real coordinates and with the linear and angular distances obtained by the CMM.

CBCT images taken of orthodontic patients must be thoroughly evaluated for diseases. Incidental findings appear on approximately 25% of CBCT images. As demonstrated, incidental findings of both skeletal and soft-tissue diseases can be detected on CBCT scans. Thus, it is imperative that the entire imaged volume is examined for pathologies or anatomic variants in patients. In an a blinded observational cross-sectional in-vitro study conducted to compare the diagnostic accuracy of observers viewing images made with CBCT, panoramic radiography, and linear tomography that detecting the cortical erosions affecting the mandibular condylar head, concluded how a major rreliability and greater accuracy is give with the use of 3dimensional imaging[20]. Moreover, some studies treat about the possibility to use CBCT not only for skeletal structures, but also of dental asymmetries[21-22].

PROPOSAL OF CLASSIFICATION BY 3D CONE BEAM

Exist a study[23] of Beak that had used 3D-CT imaging, and through some variables built a classification analysis considered standards elements representing skeletal characteristics of patients with facial asymmetry. The 8 parameters, including measurements of the upper midline deviation, maxillary canting in the canine and first molar regions, width of the upper arch, width of the mandible at the Go, vertical length of the ramus, inclination of the ramus, and deviation of the Me. They showed significant differences between the deviated side and the opposite side of the face and it's possible to establish 4 groups of asymmetry. The group 1 with mandibular body asymmetry, group 2 with unilateral condylar hyperplasia asymmetry, group 3 with atypical asymmetry, group 4 with C-shaped curve of the face in the frontal view. These could be a useful way to classify the asymmetries through analysis based on 3D-CT IMAGE.

DOSE RADIATION

An intresting study of Brown[24] shown how it's possible to reduce patient dose, with selection of exposure settings (eg, kVp, mAs) and adaptment of further technical parameters. The sample compare the reliability and accuracy of linear dimensions between common cephalometric landmarks on a sample of skulls to 3D measurements obtained from shaded surface 3D renderings reconstructed from CBCT datasets obtained from varying numbers of projection images. Patients are expose to X-ray in based of projection images aquired. This study explains how there is not difference in the quality of image if we based on the number of projection images use to create the reconstruction in the measurement obtained from 3D volumetric renderings.

In this study, 3D renderings, produced using 153 basis projection images, provided similar accuracy compared with those produced using 612. This represents a potential patient dose reduction of up to 75% and rejected the concept that many projections give a greater image. The patient receives an effective dose of only 50 μSv, because it's possible with a cone beam technology to have a full scan of the head in a few second, subjected the patient to a significative reduction of X-ray dose. Indeed, this is the same of total dose of conventional radiographs that its normal to use in an orthodontic treatment plane. The latero-lateral cephalograms and the panoramic radiograph, as well as others that has been used for others aim like the occlusal radiograph for locating impacted canines.[25,26]

Although it is an important improvement in benefit for patient, it should be uncorrected to interpret the findings of this study as adopted the use of CBCT in general orthodontic practic. It's important to realize notwithstanding the radiation reduction of CBCT compared to spiral CT, CBCT still exposes the patient to more radiation compared to a PA cephalogram[27].

Conclusion(s)

How have we previously investigated in our works, the use of 3D images with CBCT tools, lead to a many advantages, compared to 2D PA cephalograms. There is an accuracy of image because there are no more errors link to enlargement distortion and projection proper of the PA cephalograms. Moreover, we have the possibility to re built orthopanoramic and PA 2D image start from the CBCT file with the use of dedicated program. Nowadays moreover it's possible also to reduce the radiation dose. Althought, these considerations the added benefits of the 3-D images in evaluating mandibular asymmetry should be carefully weighed against the higher radiation dose before CBCT imaging can be justified and the use had to be dedicated just to a necessary situation.

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