Study of facial soft tissues with magnetic resonance imaging (MRI)

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Abstract

Alongside traditional radiology, in recent decades, diagnostics have seen the emergence of new techniques that do not employ x radiation and are therefore considered harmless and no radiating[6]. MRI allows to see human body structures differently depending on the type of reading parameters set in the device and are particularly effective for the study of the central nervous system, parenchymas, muscles and joints. Although MRI has at this time some marginal applications for odontostomatological diagnosis it can be used for imaging of temporomandibular joint and chewing muscles.

Introduction

In the past the chewing muscles has been investigated with qualitative methods such as clinical palpitation[1], while the evaluation of the muscular function was performed quantitatively with electromyography[2]. Nowadays the diagnostic methods used for soft tissue analysis include CT[3-4-5], ultrasonography and MRI. MRI utilizes the magnetic properties of the nuclei of some elements, in particular of the hydrogen that gives rise to signals emissions, in the band of radio waves, when they are immersed in an intense magnetic field and excited with radio waves. MRI is the latest in diagnostic imaging techniques and is definitely the most complex and spectacular. MRI originates from the medical application of a principle already used for some decades for the chemical-physical analysis of samples in vitro[6]. The practical realization of devices capable of carrying out these measurements on large volumes "in vivo", reconstructing diagnostic images from these data, has been made possible only in the last 20 years thanks to the advancement of technology and above all the power and speed of calculation of the computers[6]. In the past, MRI was also called Nuclear Magnetic Resonance, as the signal measured by the device and recorded in the image originates from the atomic nucleus of the examined elements. In recent years, it has been preferred to omit the term Nuclear, which is not indispensable for the definition of the process, and which can give rise to misunderstandings with the nuclear phenomena of decay, radiation and Nuclear Medicine, with which MRI does not have anything what to see.

Discussion

The MRI is the more complex chapter of images diagnostics both from a diagnostic interpretative point of view and for the complexity of physical phenomena that preside of the reading of the signal and the formation of images, phenomena that are in many cases determinant to obtain iconographic pictures also very different from each other. For the time being MRI has only a few marginal applications for odontostomatological diagnostic [6]. It is reported in the literature that magnetic resonance imaging is used for imaging of temporomandibular articulation and chewing muscles[7-8-9-10-11-12] ; MRI is a non-invasive imaging technique that allows you to obtain high-quality soft-tissue images without any adverse effects due to the absence of radiation (Budinger and Cullander,1984; Wolff et al., 1985; Aanchez-Woodwoth 1987). MRI allows for frontal, horizontal, sagittal, and angled scans without changing the patient's position[13].

MRI images allow you to see human body structures differently depending on the type of reading parameters set in the device and are particularly effective for the study of the central nervous system, parenchymas, muscles and joints[6]. In the literature there are studies that using MRI to investigate the cross section of chewing muscles in healthy patients with different craniofacial morphology and also studies that comparing the application of MRIÂ both with ultrasound and CT , to analyze different characteristics of chewing muscles.

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In the study of Raadsheer et al.[14] in which masseter muscle thicknesses were compared in 15 patients by ultrasound and MRI concluded that the measurement of masseter muscle thickness with the MRI is therefore superior, more accurate than that measured by ultrasound. For all muscle levels a lower thickness was observed with the ultrasound examination than MRI. An explanation might be that superficial muscular aponeurosis has not been included in ultrasonic measurements, as opposed to MRI measurements. In addition, the transducer pressure, though very light, could reduce the thickness of relaxed muscle. Other studies compared RMI with CT. As a technique of imaging, MRI is preferable to CT because it allows serial scans with different angles without changing the patient's position and also provides the possibility to determine a single cross-section, which allows to evaluate the orientation of chewing muscles (Spronsen et al., 1988; Sasaki et al., 1989; Koolstra et al., 1990). As for the cross-sectional imaging of the chewing muscles, we note the study of Spronsen et al.[13]; They describe the use of 3D-CTMD in the imaging of the cross-section of chewing muscles (Weijs and Hillen, 1985) and then they compare the results obtained with MRI scans that was effettuate in the same sample of 12 subjects which did not exhibit cranial, occlusal or functional abnormalities. The importance of measuring cross sections of chewing muscles has been underlined in the morphometric studies of chewing muscles (Weijs and Hillen 1984,1985; Newton et al. 1987, Hannam and Wood, 1989).This study shows that both magnetic resonance imaging and 3D-TCMD can be used to measure the cross section of chewing muscles. The authors also note that because of its specific morphology, the imaging of the transverse cross-section of the temporal muscle with RMI is less accurate than 3D-CTMD, but still acceptable; RMI imaging of the cross-sections of the lateral pterygoid muscles is not accurate, therefore, it is preferable for this muscle to resort to 3D-CTMD reconstruction. So a good overlap was obtained only for masseter muscle and medial pterygoid muscle. For lateral pterygoid and temporal muscle, a lower degree of overlap was found. Differences observed between 3D-CTMD and RMI images can be attributed to differences in imaging techniques (patient scanning positioning, layer thickness) and muscle contour determination problems. Problems with the determination of temporal muscle contours were reported by Hannam and Wood (1989) that excluded this muscle and lateral pterygoid muscle from their study. They argue that temporal muscles and lateral pterygoid muscles are more susceptible to scanning errors or errors in positioning of the patient due to their morphology and their specific orientation than the mean-sagittal plane. MRI imaging is very important in patients with temporomandibular joint dysfunction, because it allows evaluation of external pterygoid muscle. In fact, D'Ippolito et al. have shown that MRI imaging obtained in oblique sagittal planes allows for a detailed observation of the external pterygoid muscle, the articular disk, the mandible condyle, the glenoid fossa, and the relationship between the structures in the same image[12]. Both heads of the external pterygoid muscle are clearly observed in all the MRI images analyzed by D'Ippolito et al., demonstrating that this diagnostic method is effective for its evaluation. Despite the fact that the MRI provides good information on the position and relationships between the above structures, it is not accurate for assessing the thickness of the external pterygoid muscle. There are studies that have tried to correlate facial typology and different characteristics of chewing muscles with MRI. W. Weijs et al. submitted 32 male patients with normal skull shape, complete tooth, no severe malocclusion and functional disorders of temporomandibular joint to MRI examination[12]. The purpose of this study was to determine a possible association between the cross section in the middle of the bellies of the levator mandibulae muscles and the anterior belly digastric muscle and normal skull morphology. The results of this study were compared with previously published data on cross-sectional areas and volumes of human chewing muscles obtained by CT and MRI (Weijs eHillen 1984, 1985; Spronsen et al., 1989; Sasaki et al. 1989; Gionhaku and Lowe, 1989; Hannam e Wood, 1989). The authours found: significant and positive correlations between the linear measurements of the transverse dimensions of the skull and the maximum cross section of temporal muscle and masseter and negative correlations between the angle of the skull base and the cross section of temporal muscle. Surprisingly, no significant correlations have been found between front or back facial height and the transverse cross section of any of the examined chewing muscles. The study concludes that, in adult males with normal skull shape, there is limited relationship between skull and facial morphology and areas of the cross-section of chewing muscles. The cross-sectional area of the digastric muscle found by Weijs et al. is higher than that found by Primum et al. 1980.

Hannam and Wood(1989) found significant correlations between cross-sectional areas and volume of masseter and medial pterygoid muscle and skull-facial morphology; therefore they are in disagree with Weijs et al..

It is interesting to note that the average cephalometric characteristics of Weijs et al. and those of Hannam and Wood are comparable. This indicates that the differences found in cross-section areas of chewing muscles are due to differences in imaging techniques rather than changes in shape of the skull. It is widely accepted that there is an interaction between the function of chewing muscles and craniofacial growth. One of the variables of muscle function is the maximum force that a muscle can produce; this strength is proportional to the physiological section, that is, to the total cross-section of all muscle fibers, which in turn is linked to the cross-section of muscle (Weijs eHillen, 1984). Some cephalometric variables are related to the muscle section as recorded by CT (Weijs eHillen, 1984) or MRI (Hannam and Wood, 1989 Van Spronsen et al., 1991) or with muscle thickness as recorded with the ultrasound (Kiliaridis and Kalebo, 1991; Bakke et al., 1992).

Conclusion

The MRI technique does not employ X radiation and is thus considered to be an innocuous and non-irradiating method; has no cumulative biological effects and is most suitable for larger scale studies. Although the MRI has for the time being only a few marginalized applications for odontostomatological diagnosis it can be used for imaging of temporomandibular joint and chewing muscles. Currently the MRI has only some marginal applications for odontostomatological diagnosis, it can be use for imaging of temporomandibular joint and chewing muscles. MRI allows linear measurement of the muscles and itÂ can be performed for each of the three dimensions of the space: transverse, vertical, and sagittal. Linear measurements in each floor of the space can be used to calculate an indicative volume. In addition, the MRI allows a functional soft tissues study. MRI can be used to measure the cross section of chewing muscles, but often due to specific muscular morphology, MRI cross-sectional imaging of some chewing muscles is less accurate and precise than that with CT. Further investigations on the use of MRI for the study of chewing muscles and facial soft tissues are desirable both in the subject with normal facial skull morphology and in the subject with facial skull deformity.

References

1) CE Huisinga-Fischer*,1,2, JM Vaandrager3, FW Zonneveld4 and B Prahl-Andersen1,2Precision and accurancy of CT-based measurements of masticatory muscles in patients with hemifacial microsomia. DentomaxillofacialRadiology (2004) 33, 12â€“16

2) Grabb WC. The first and second branchial arch syndrome. PlastreconstrSurg 1965;36:485-50

3) Kane AA, Lo LJ, Marsh JL, et al.The relationship between bone and muscle of mastication in hemifacial microsomia; PlastReconstrSurg 1997;99:990-997

4) Nakata S, Mizuno m, Koyano K, et al. Functional masticatory evaluation in hemifacial microsomia. Eur J Orthod1995;17:273-280

5) Marsh JL, Baca D, Vannnier MW. Facial muscoloskeletal asymmery in hemifacial microsomia; Cleft Palate J 1989; 26:292-302

6) Renato Nessi; Luca ViganÃ²;Radiologia odontostomatologica per odontoiatri, medici e studenti, Piccin 2004. Capitolo 7:73

7) Weijs WA, Hillen B. Relationships between masticatory muscle cross-section and skull shape. J Dent Res 1984;63:1154â€“7.

8) Gionhaku N, Lowe AA. Relationship between jaw muscle; volume and craniofacial form. J Dent Res 1989;68:805â€“9.

9) van Spronsen PH, Weijs WA, Valk J, Prahl-Andersen B, van Ginkel FC. Comparison of jaw-muscle bite-force cross- sections obtained by means of magnetic resonance imaging and high-resolution CT scanning. J Dent Res 1989;68: 1765â€“70.

10) Kitai N, Fujii Y, Murakami S, Furukawa S, Kreiborg S, Takada K. Human masticatory muscle volume and zygomatico- mandibular form in adults with mandibular prognathism. J Dent Res 2002;81:752â€“6.

11) H.P.W. Boom a,b,*, P.H. van Spronsen a,b, F.C. van Ginkel a, R.A. van Schijndel d, J.A. Castelijns c, D.B. Tuinzing A comparison of human jaw muscle cross-sectional area and volume in long- and short-face subjects, using MRI; Archives of oral biology 53 (2008) 273â€“281

12) van Spronsen PH, Weijs WA, Valk J, Prahl-Andersen B, van Ginkel FC. Relationships between jaw muscle cross-sections and craniofacial morphology in normal adults, studied with magnetic resonance imaging. Eur J Orthod 1991;13:351â€“361

13) P.H. van Spronsen et al.; Comparison of jaw-muscle bite-force cross sections obtained by means of mri and high resolution ct scanning;J Dent Res December 1989:1765-1770

14) SM Dâ€™Ippolito, AM BorriWolosker, G Dâ€™Ippolito, B Herbert de Souza and M Fenyo-Pereira; Evaluation of the lateral pterygoid muscle using magnetic resonance imaging,The British Institute of Radiology; Dentomaxillofacial Radiology (2010) 39, 494â€“500