

Use of MRI in Orthodontics - A Review **Aakash Shah***

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Citation: Shah A (2017) Use of MRI in
Orthodontics - A Review. J Imaging Interv
Radiol Vol.1 No.1:3

Abstract

The use of repetitive maxillofacial imaging to monitor the progress of orthodontic treatment is essential to effectively treat orthodontic patients. Three dimensional imaging is rapidly replacing traditional radiographic methods. This new technology is particularly helpful with orthodontic concerns such as root length, bone structure, and root angulation. In contrast to CBCT imaging, MRI uses non-ionizing electromagnetic radiation. MRI allows for repetitive 3-D imaging of dental structures in any age group without worrying about potential harmful radiation exposure.

Keywords: MRI; CBCT; Craniofacial imaging

Received: September 21, 2017; **Accepted:** October 09, 2017; **Published:** October 12, 2017

Introduction

Repetitive Maxillo-facial imaging is often used to monitor the progress of orthodontic tooth movement. Currently three dimensional (3-D) imaging is being utilized to improve assessment of the Dento-facial structures. This new 3-D technology is particularly helpful in orthodontics to monitor root length¹, bone structure¹, and root angulation [1,2].

Standard Computed Tomography (CT) has radiation doses that are too high to justify CT use in typical orthodontic situations. Current Cone Beam Computed Tomography (CBCT) machines have smaller radiation doses making CBCT “safer” for most orthodontic needs [3]. It is important to note that CBCT radiation doses are still significantly higher than normal dental radiography. A normal dental FMX series of analog radiographs exposes the patient to about 0.150 micro Sieverts [4]. Analog panoramic radiographs expose the patient to 54 microsieverts [5]. The effective dose for a single CBCT is 58.9-1025.4 micro Sieverts [6]. These numbers can be compared with the 3000 micro Sieverts average annual natural background radiation. The American Dental Association (ADA) recently stated that radiation procedures like CBCT must be used sparingly and only for situations that are deemed necessary for diagnosis [7]. Radiation exposure should be as low as reasonably achievable (ALARA) [7,8].

The ADA released a statement in December 2012 regarding the use the CBCT in dentistry. The statement recommends being careful with patient selection and limiting radiation exposure. In addition dentist should use their professional judgment and weigh the risks and benefits when exposing patients to radiation.

The ADA also endorses the ALARA principle when prescribing dental x-rays [9].

Additionally a joint statement was released by the American Association of Orthodontists (AAO) and the American Academy of Oral and Maxillofacial Radiology (AAOMR) regarding the use of CBCT in orthodontics. The statement says radiographic imaging should be based on the findings of a clinical exam. The benefits of the radiation exposure must always outweigh the risks. CBCT should not be considered routine but a supplement to two-dimensional (2-D) radiographic imaging [10].

Magnetic resonance imaging

Another form of 3-D imaging available to medical professionals is Magnetic Resonance Imaging (MRI). In contrast to CBCT, MRI uses non-ionizing electromagnetic radiation [11]. MRI allows for repetitive 3-D imaging of dental structures without potential harmful radiation exposure [12]. MRI should be considered first choice for pre-procedural imaging assessment for implant placement [13].

MRI is now the gold standard for temporomandibular joint (TMJ) imaging because it is used to see the soft tissue component of the joint.

Advantages to MRI

- 1) Ability to image the TMJ and disk,
- 2) Display of soft and hard tissues,
- 3) Safe to use for patients, who are allergic to the contrast agent,

- 4) All images can be obtained without repositioning of the patient, and
- 5) The ability to see inflammatory processes [3].

Some disadvantages to MRI include

- 1) Cost of equipment and cost to patients.
- 2) Accessibility and availability in medical and dental centers.
- 3) Increased possibility of motion artifact due to the length of time to obtain an image. Hard tissues not recorded as well [3,4].
- 4) Discomfort of claustrophobic patients being confined to a small space, and
- 5) Possible increased incidence of amalgam micro leakage [14].

Another issue is the artifact caused by stainless steel and other metal orthodontic appliances making MRI a problem for patients who are undergoing orthodontic treatments [3]. MRI procedural protocol provides an additional disadvantage because all patients should be screened for the presence of metal objects that may become dangerous projectiles when in proximity to the electromagnetic field [15].

MRI works by recording a resonance signal from the excited hydrogen atoms created by a magnetic field. The scanner is a magnetic field surrounding the patient and gradient coils are turned on and off to vary the magnetic field. As the magnetic field excites atoms and then an equilibrium state energy is sensed. The energy from radio waves and the magnetic field is converted to a number which is processed by a computer and then converted to an image. MRI images the water in the tissues. Different tissues with different water content will display differently on the image [3].

A recent study concluded that MRI and CBCT images showed similar linear measurements [16]. CBCT was shown to be more accurate than per apical radiographs for measuring tooth lengths [17]. Additionally, CBCT measurements are not significantly different from actual tooth length measurements. Other studies have confirmed the ability of CBCT to accurately measure

distance and linear measurements [18,19].

The location of impacted teeth is important in orthodontic treatment planning. A prospective study evaluated the diagnosis of impacted teeth using MRI. Impacted teeth were clearly distinguishable from surrounding tissues. In addition, the position and angulation of impacted teeth could be determined in three dimensions. The study achieved accurate analysis of full volumetric morphology of impacted teeth without exposure to ionizing radiation [20]. Another study used MRI to locate impacted teeth [21]. All impacted teeth were located except one tooth in one patient. This study indicates MRI gives us valuable information without the need for ionizing radiation. "MRI is a safe, well-tolerated imaging method which can be used for three-dimensional localization of impacted teeth in both adults and children."

A study looked at improving the contrast of the teeth and jaw during MRI scans. This study described teeth as being "MR-invisible." However, by surrounding the teeth with an "MR-visible" medium the tooth crowns were able to be viewed indirectly [22].

It is now possible to detect signals from tissues and tissue components using ultra short TE (UTE) pulse sequences. A recent study was conducted to determine if UTE-MRI (Ultra short Echo Time-MRI) could be used to image extracted premolar teeth. Linear tooth measurements from the MRI scan were statistically and clinically accurate. Different tooth tissues could be delineated on the MRI scans [23].

Conclusion

Orthodontic patients are generally young and more susceptible to the harmful effects of ionizing radiation. We must make every effort to minimize or eliminate the exposure of our patients to ionizing radiation. The ability to use MRI in orthodontic diagnosis and screening could be an important step in the right direction because it would completely eliminate the patients' exposure to ionizing radiation, at least at initial screening and diagnosis. The principle of ALARA would be put to maximum effect.

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