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Review Article

MRI in Orthodontics-A Review

Smaraki Mahapatra* and Deepankar Bhatnagar

Department of Orthodontics and Dentofacial Orthodontics, MMCDSR, Haryana, India

***Corresponding Author:** Smaraki Mahapatra, Department of Orthodontics and Dentofacial Orthodontics, MMCDSR, Haryana, India.

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Abstract

Magnetic Resonance Imaging (MRI) is a 3D imaging technique used by medical professionals for examination and diagnosis of various kinds of tissue. It uses magnetic field, radio waves and electric field to produce images in the body in multiple planes. It is one of the safest techniques used in medical and dental field to visualize the soft tissue anomaly and detect pathology without exposing the body to harmful radiation. It uses non-ionizing radiation, which are sensitive, noninvasive and very specific in nature. It is a useful diagnostic tool for spinal and brain disorders owing to its excellent soft tissue contrast.

Keywords: MRI; Imaging; Soft Tissue

Introduction

MRI is one of the non-invasive imaging techniques that have superior soft tissue contrasts and potential physiological and functional applications [1]. As MRI does not expose the body to radiation, it has become a mainstay of non-invasive diagnostic radiology modality since 1980s. MRI uses very powerful magnetic field, rapidly changing magnetic fields, radio waves, and a computer to obtain detailed images [2]. A clinical demand for MRI has increased, healthcare professionals have to be trained in MRI safety to protect patients from the potential risks of MRI [3].

History

Magnetic Resonance Imaging (MRI) was invented by an American Chemist Paul Christian Lauterbur in 1971 for which he was awarded the Nobel Prize. Then in early 1980s, the first clinical Magnetic Resonance Imaging scanners were installed. The application was further applied in science by Peter Mansfield who also received Nobel Prize in 2003 for his contribution to the development of MRI. Significant development in the technology has occurred since the following decades, leading to its widespread use in medicine and dentistry today [4,5].

Working Principle

The working of MRI machine (Figure 1) is based on the signal of nuclear magnetic resonance (NMR) emitted by the interaction of atomic nuclei that possess spin with incident radiofrequency within a static magnetic field. Generally, each Magnetic Resonance Imaging (MRI) device works with a particular set of coils including (Figure 2) main coil, gradient coil, radiofrequency coil, receiver coil and shim coil. There are three type of substances with different magnetic susceptibilities that need to be considered in magnetic Resonance Imaging (MRI), namely: Ferromagnetic materials (iron, cobalt, nickel), Diamagnetic materials (copper, gold, zinc, lead, carbon, bismuth) and Para-magnetic materials (chromium, manganese and aluminium) [6].

Magnetic resonance (MR) image is produced by placing the patient inside the large magnet, which induces a relatively strong external magnetic field. This causes the nuclei of many radiofrequencies signal to release energy from the body and is further detected and used to construct the Magnetic Resonance image by the computer. Magnetic Resonance imaging is based on the principle that the nuclei of some atoms are capable of spinning and they generate

Figure 1: MRI machine.

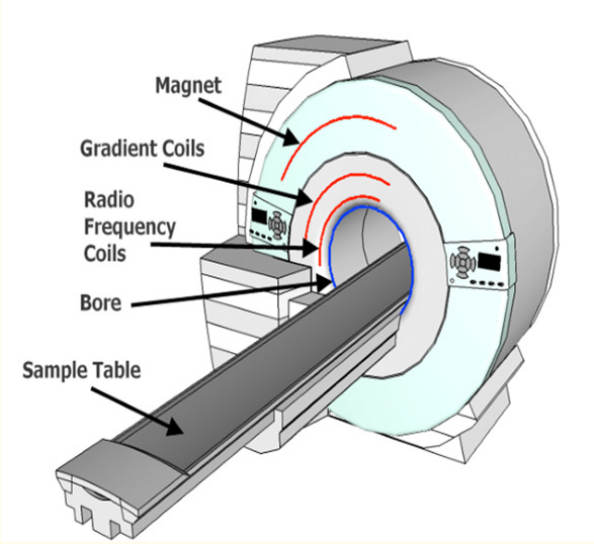

Figure 2: MRI machine parts.

a magnetic field in the process. It mainly makes use of hydrogen. The tissues to be analyzed are placed in strong magnetic field. Since large number of hydrogen atoms present in the tissues behave like tiny magnets, they get aligned with the magnetic field. When a radio signal is used, these tiny magnets flip 90 or 180 degrees depending on the amplitude and duration of the signal and get misaligned with respect to the magnetic field. When the Radiofrequency (RF) is stopped, the nuclear magnets relax and flip back in alignment with the magnetic field. As these nuclei relax, they transmit a radio signal whose frequency is unique to the element and a signal strength that is indicative of the element in abundance. An image or Magnetic Resonance image is constructed by a computer using these radio signals [6,7].

Use of MRI

MRI has many uses in orthodontics such as [8,9]

- **Assessment of TMD:** MRI can be a valuable tool for diagnosis of normal and abnormal disc position in many patients. It can also be used to determine the relationship of the disc to the condyle.
- It is used for diagnosing various temporomandibular disorders such as TMJ arthritis, Joint mice, Rheumatoid arthritis and used for assessment of abnormal jaw muscles. It is now the gold standard for TMJ imaging because it is used to see the soft tissue component of the joint.
- **Assessment of tongue volume:** MRI can be used to assess the tongue volume correctly.
- **Assessment of hypopharynx and oropharynx sizes:** MRI is used for correct size of hypopharynx and oropharynx sizes
- **Assessment of tumors and cancer staging**: MRI scanning is also helpful for assessment of tumour and its size, its staging. It saves patients from many dangerous health hazards. It provides us information for early detection of cancer.
- **Assessment of growth data:** MRI can be used to collect the growth data (Figure 3) without exposing the patient to radiation hazards.

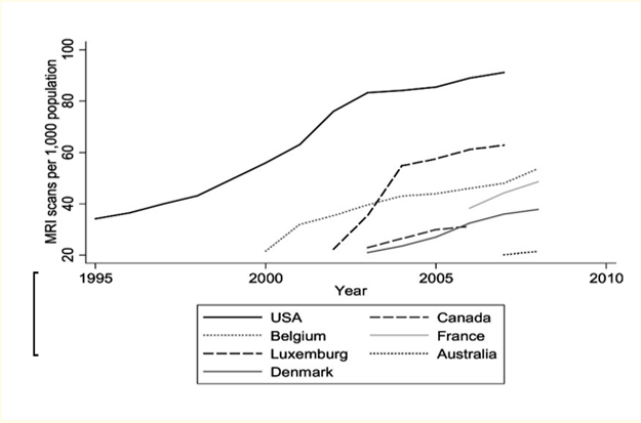

Figure 3: MRI scanning for the growth data.

Advantages of MRI in orthodontics [10,11]

- MRI helps orthodontists in treating diseases related to airway like sleep apnoea.
- MRI completely eliminates the patient's exposure to ionizing radiation.
- MRI is more accurate than peri-apical X-rays for measuring tooth lengths.
- MRI allows for repetitive 3-D imaging of dental structures in any age group without worrying about potential harmful radiation exposure to monitor the progress of orthodontic tooth movement.

MRI produces clearer images compared to a CT scan. In instances when we need a view of soft tissues, an MRI is better option than x-rays or CTs. MRIs can create better pictures of organs and soft tissues, such as torn ligaments and herniated discs, as compared to CT images.

Disadvantages of MRI

There are many disadvantages of MRI in orthodontics such as [10,11].

- The equipment is very costly and is very costly to patients also.
- Accessibility and availability in medical centers.
- Increased possibility of motion artifact due to length of time to obtain an image.
- Hard tissues are not recorded properly.
- It is very discomfortable to claustrophobic patients.

Conclusion

Since Damadian's time MRI has improved a lot by it's function or workability. It's cost and demand has also increased by the day passed. Now, it has a promising future in dentistry. Though it has many disadvantages, it is very useful. MRI has many uses such as during TMJ examination and diagnosing serious diseases e.g. It is used during orthognathic surgeries for evaluation of soft tissues. So, orthodontist should have knowledge about MRI procedure before and after orthodontic treatment as it causes tissue metal artefacts and image distortions. Some precautions should be taken to prevent radiation hazards [12-16].

MRI has done tremendous changes in the medical science and also in the orthodontic field, which brings easier diagnosis and treatment of many patients. It is excellent in the aspects of diagnosing the soft tissue lesions than hard tissues. Although the MRI is very costly, it saves many patients from upcoming dangers e.g. diagnosing tumors and cancers, whose early detection is very important for it. In this aspect, it is a blessing to our medical field, as it saves many lives. Although its use in orthodontic field is very limited, it diagnoses many dangerous diseases such as TMJ disorders (e.g., -Inflammation of retrodiscal pad), Trigeminal neuralgia, ligament injury, etc. before and after orthodontic treatment. Clinicians and orthodontists over the world can get very much benefit from this MRI procedure [17-20].

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