

**CLINICAL
SECTION**

The Benefits of Aesthetic Orthodontic Brackets in Patients Requiring Multiple MRI Scanning

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MRI scans are increasingly used diagnostically in medicine. Scans of the head and neck region can be distorted by metallic components in the vicinity. This paper discusses the consideration for aesthetic brackets (with no metal components) on all teeth including molars in patients requiring MRI scans and especially if those need to be repeated on a regular basis.

Key words: Aesthetic brackets distortion/interference, MRI

Received 15th August 2005; accepted 14th February 2006

Introduction

Magnetic resonance imaging (MRI) is one of the most powerful diagnostic tools in radiology and diagnostic science. It is non-invasive and non-ionizing, and the images can be highly sensitive and specific. MRI 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 field¹.

MRI can be used for assessment of intra-cranial and extra-cranial lesions, particularly those involving the soft tissues. The system does not use ionizing radiation and there is little risk associated with application of magnetic fields to the majority of people.

MRI is expensive and is not appropriate for claustrophobic patients. It does not show cortical bone and patients with certain indwelling metal components should not be scanned. This paper illustrates alternatives to metal bands and fixed metal brackets for patients undergoing fixed orthodontic treatment that need regular head and neck MRI scans.

All substances when placed in a magnetic field are magnetized to a degree which varies according to their magnetic susceptibility. There are three types of substances with different magnetic susceptibilities that need to be considered in MRI, namely:

1. Ferromagnetic materials which strongly amplify the magnetic field, such as iron, cobalt and nickel.^{1,2}
2. Diamagnetic materials which slightly weaken the magnetic field, such as copper, gold, zinc, lead, carbon and bismuth.^{1,2}

3. Para-magnetic materials which slightly amplify the magnetic field, such as chromium, manganese and aluminium.^{1,2}

Metal materials with magnetic properties cause an artefact which is similar to a 'black hole' in the final picture which can lead to a misinterpretation of the MRI results^{3,4} (Figures 1 and 2).

An artefact may be defined as a distortion of signal intensity or void that does not have any anatomic basis in the plane being imaged.⁵ The size and shape of the artefact depends on the magnetic properties of the metal object examined, on its size and shape, space orientation and the homogeneity of the alloy.

Dentists usually use precious (Au, Ag, Pt) and non-precious alloys (Cr, Co, Mo, Ni), pure gold, titanium and titanium alloys².

Behr *et al.*⁵ and Tetsumura *et al.*⁶ studied the effect of metals on MR images of the TMJ. Although they confirmed the presence of such artefacts in that region, the findings of Hinshaw *et al.*⁷ suggested that dental filling materials such as gold and amalgam did not produce artefacts, whilst Abbaszadeh *et al.*⁸ showed that gold caused the most and amalgam the fewest artefacts on the MR images.

Okano *et al.*⁹ suggest that ceramic brackets and direct bonded metal tubes do not affect the diagnostic quality of the MRI scans in TMJ imaging.

Stainless steel and other metals used in prosthetic dentures and orthodontic braces have been found to create substantial artefacts that tend to obliterate image details in the facial area.



Figure 1 MRI scan of the naso ethmoidal complex in a 13 year old child

Figures 1 and 2 show the ‘black hole’ created by the presence of upper and lower metal fixed appliances on an MRI scan of the naso ethmoidal region. There is complete loss of signal over the facial tissues with the maxilla and mandible not visible due to the loss of signal intensity.

Case report

LB was initially referred to the Oral and Maxillofacial Surgery and Orthodontic department at Gloucester Royal Hospital in 1996 for orthodontic assessment.

She was medically fit and healthy. She presented in her mixed dentition stage with a class II division 1 incisor relationship but with an unerupted upper left central incisor. A supernumerary was removed under general anaesthesia, a space maintainer fitted and she was kept under review.

In 1999 at the age of nine LB was referred by her GP to the Paediatric Oncologist regarding proptosis of the left eye. The diagnosis of optic nerve glioma (Pilocytic Astrocytoma) was made. This is a benign tumour with a survival rate of 100% and was initially treated with chemotherapy in 2001.

Subsequent to this her visual acuity dropped and the tumour had to be resected. The operation was successful and subsequent MRI scans did not show any evidence of recurrence. This patient requires 6-monthly MRI scans of the head and neck region to monitor the tumour.

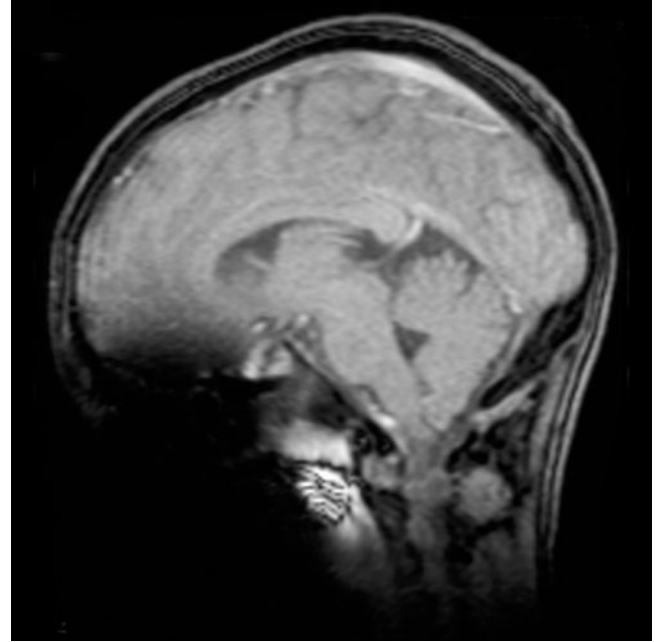


Figure 2 MRI scan of same patient with metal orthodontic brackets in place

At the age of 12 a twin-block appliance was fitted in order to reduce her 7 mm overjet, prior to upper and lower fixed appliance therapy.

In order to reduce or eliminate the risk of artefact formation on the MRI scans due to metal orthodontic fixed appliances, it was felt that non-metallic aesthetic orthodontic brackets including bonded ceramic molar attachments may reduce the distortion on future MR images (Figure 3).

The brackets used (Brilliant brackets, FOREST-ADENT) are made of polyoxymethylene homopolymer (POM) which gives them high colour stability, low friction and high wear resistance and should not produce artefacts on MRI scans. To test this hypothesis the brackets were embedded in a vacuum formed acrylic appliance and with the agreement of the Consultant Radiologist, patient and parents, MRI scans were taken of the patient with and without the appliance. There was no distortion detected in the scans with or without the aesthetic brackets.

It was felt by the radiologists that aesthetic, non-metallic brackets could be used by the orthodontists in this case to avoid the need for complete appliance removal prior to MRI scanning. The archwire was removed on the morning of a scan and replaced once the scan was complete.

Discussion

On occasion it is necessary for a patient undergoing or about to start orthodontic treatment to have MRI scanning.



Figure 3 Brilliant brackets on the study models. (a) Upper arch prior to fixed appliance; (b) Aesthetic brackets applied to upper model including molars; (c) Aesthetic brackets applied to upper model; (d) Occlusal splint with aesthetic brackets embedded prior to test MRI

The orthodontist should be aware of the effects of orthodontic appliances on head and neck MRI scans and how the diagnostic quality of these scans can be affected. As a practical matter of clinical significance, metallic fixed appliance brackets and orthodontic archwires can increase distortion and artefact in MR images^{4,9}. It would be prudent for an orthodontic patient to have archwires with fixed appliance metal brackets and bands, removable appliances, removable palatal bars, lingual arches etc. removed prior to an MRI scan. Consideration should be given to bonding or re-bonding with aesthetic or ceramic brackets. It is then

a simple procedure to remove the wire prior to the scan and replace it shortly afterwards without the need for full appliance removal. Alternatively, fixed appliance placement should be delayed until after all investigations are carried out, especially in those cases likely to require 'one-off' scans.

Our experiences with bondable ceramic molar tubes have been encouraging. Eliminating metallic parts of the orthodontic appliance should adequately ensure diagnostically useful quality of the scans. Complete removal of fixed orthodontic appliance components may not be necessary unless the region of interest in the scan is close



Figure 4 Normal MRI scan with patient wearing no brackets



Figure 5 MRI scan with patient wearing aesthetic brackets on occlusal splint (NB: no metal actually present – film inscription error)

to the mouth, where they could cause unacceptable artefacts. This would be of little concern with non-metallic appliance components.

Conclusion

- Metallic objects in head and neck region can distort MRI images, reducing their diagnostic value.
- Metallic orthodontic appliances can provide this distortion.
- Aesthetic brackets including molars (with no metal components and with the archwires removed) do not appear to distort MRI scans.

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