Effect of keeper after MRI irradiation on attractive force

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Abstract

The purpose of this study was to evaluate the attractive force of the dental magnetic attachment before and after MRI irradiation against the keeper.

Duplicate the lower non-magnetic table of the ISO tensile test jig with an immediate polymerization resin, and then attaching the magnetic assembly to the upper non-magnetic table of the jig and each keeper to the lower duplicated resin table. The attractive force before irradiation was measured with a universal tensile tester. Next, a resin-made table with a keeper was placed in a mold that assumed the upper and lower incisors, premolars, and molars, and the attractive force was measured after MRI irradiation for about 16 minutes.

There was no significant difference in the suction force before and after irradiation, and it was found that there was no problem with the attractive force even if MRI irradiation was performed for the patient with keeper.

Introduction

There are some reports that patients with dental magnetic attachments have decreased attractive force after MRI irradiation. In this study, MRI was irradiated to a commercially available magnet keeper, and verification was performed by measuring the attractive force of the dental magnetic attachment before and after irradiation against the keeper.

Materials and Methods

1． Duplication of lower non-magnetic table

Prior to the experiment, 6 of the lower non-magnetic table of the ISO tensile test jig

were duplicated with an immediate polymerization resin (Orthocrystal, Nissin), the magnetic assembly (Hyper Slim 4813 magnet structure, NEOMAX) was placed on the upper non-magnetic table (Fig.1), and the duplicated lower non-magnetic table was mounted. A keeper (DB keeper 4813, NEOMAX) was adhered to the lower non-magnetic table (Fig.2).

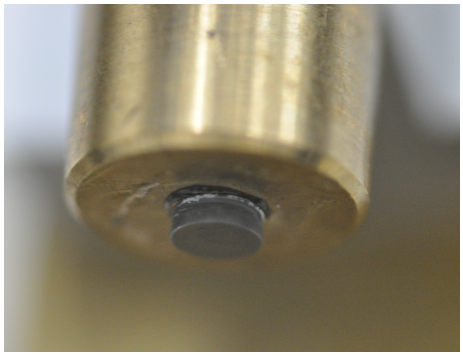

Fig.1 Upper non-magnetic table with magnetic assembly.

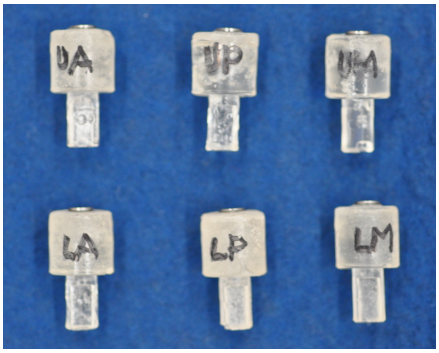

Fig.2 duplicated lower non-magnetic tables with keeper.
UA: upper anterior, UP: upper premolar
UM: upper molar, LA: lower anterior
LP: lower premolar, LM: lower molar

2. Tensile test

An ISO tensile test jig was attached to a universal tensile tester (Autograph AGS-H, Shimadzu Corp.), and the attractive force before irradiation was measured at a crosshead speed of 5 mm /min (Fig.3).

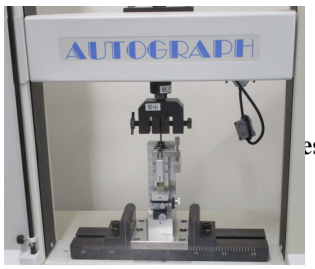

Fig.3 Universal tensile tester with ISO est jig.

3. Fabrication of mold for MR imaging

Next, an acrylic mold that assumed six upper and lower anterior teeth, premolars, and molars was fabricated (Fig.4). The positions of the upper and lower central incisors, first premolars, and second molars were determined with reference to the report by Takigami et al.[1]. The distance from the occiput to the distal end of the second molar was calculated from MR images stored at the Department of Dental Radiology, Kyushu Dental University Hospital.

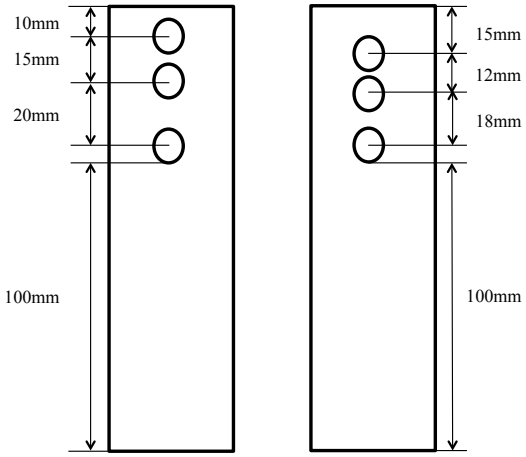

Fig.4 Fabricated mold for MR imaging

After fixing the upper and lower molds on the acrylic plate, a socket was provided to fix each lower non-magnetic tables using silicone putty. The distance between the upper and lower mold was 40 mm (Fig.5,6).

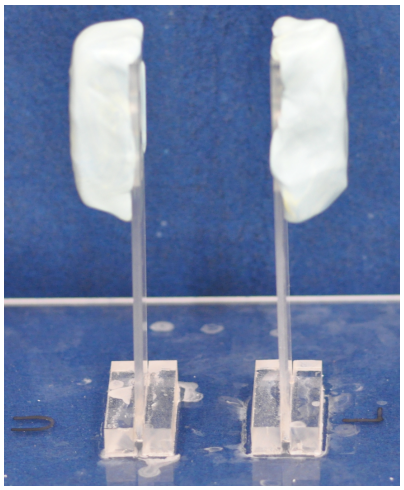

Fig.5 Upper and lower molds fixed on the acrylic plate

Fig.6 Lower non-magnetic tables set into the sockets

4. MR imaging

The mold with the lower non-magnetic table with keeper was installed in the gantry of MRI (1.5-T, full-body, MR system (EXCELART Vantage^{TM} Powered by Atlas; Toshiba, Tokyo, Japan)). It was irradiated for about 16 minutes to image the head and neck tumor. The attractive force of the keeper after irradiation was measured by the same method as before irradiation and the attractive force before and after irradiation was compared and examined.

Results

Table 1 shows the results of evaluation of the attractive force of the magnetic attachment before and after MRI irradiation on the keeper.

Table 1 Results of evaluation of the attractive force of the magnetic attachment before and after MR irradiation on the keeper.

position	before	after	p−value
UA	6.20±0.08	6.47±0.25	N.S.
UP	8.22±0.56	8.78±0.04	N.S.
UM	8.96±0.20	9.54±0.05	N.S.
LA	4.42±0.42	5.75±0.04	N.S.
LP	4.87±0.12	4.97±0.10	N.S.
LM	8.48±0.58	9.49±0.10	N.S.

The attractive force of Hyper Slim 4813 is displayed as 9.6N. The attractive force of the magnetic attachment using the keeper before MRI irradiation has a large variation of 4.42N to 8.96N on average, which is considered to be a technical error when bonding the keeper to the lower non-magnetic table. Similarly, the attractive force after irradiation has 4.97 N to 9.54 N on average and the attracive force tended to increase after MRI irradiation.

The attractive force before and after MRI irradiation at each position was examined, and no significant difference was observed at all positions. It was found that there was no problem with the attractive force even when the keeper was irradiated with MRI.

Discussion

Tsuchibashi et al.[2] described that when an MRI examination was performed with a denture with a magnetic attachment, significant artifacts were generated, and the spontaneous magnetization of the magnet portion was reduced due to the magnetic field of the MRI, which reduced the attractive force. It is reported that MRI must be performed after removing the denture, which seems to be performed at most facilities in Japan.

On the other hand, there have been reports of keeper dropout during MRI examinations[2], and cases where the attractive force of the magnetic attachment decreases after MRI examinations[3]. In this regard, Yamamoto et al.[4] reported that in a static magnetic field of MRI, a torque was generated so that the keeper surface became

parallel to the magnetic field, and the keeper was displaced very slightly, and the condition of contact with the magnet assembly changed. In addition, in an object with anisotropic shape such as a keeper, the magnetization induced inside the object varies depending on the direction of the object in the magnetic field, and as a result, the torque in which the long axis direction of the object points in the direction of the magnetic field. In other words, the long axis of the object tends to be oriented in the direction of the magnetic field.

In this experiment, there was no significant difference in the attractive force before and after MRI irradiation to the keeper in all six positions. Therefore, there is no problem in the attractive force even if MR imaging is performed while the keeper is worn in the oral cavity. In addition, a tensile test using a keeper after MRI irradiation showed a tendency for the attractive force to increase at any positions. It is possible that the keeper itself is slightly magnetized by MRI irradiation, but we will discuss the details in the future.

Conclusion

In a case report that a patient with a dental magnetic attachment had reduced the attractive force after MR imaging, the authors verified the case by irradiating a commercially available magnetic keeper with MRI and measuring the attractive force of the dental magnetic attachment before and after irradiation. It was found that there was no problem with the attractive force even if MRI irradiation was performed for the patient with keeper.

Conflict of interest

Regarding this report, there is no conflict of interest among all authors.

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