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# The use of a neodymium–iron–boron magnet device for positioning a multi-stranded wire retainer in lingual retention—a pilot study in humans

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SUMMARY The aim of this study was to evaluate the time requirement of a newly developed device made of neodymium–iron–boron (NdFeB) magnets for positioning a multi-stranded, canine-to-canine retainer during bonding compared with dental floss and a transfer tray.

Forty-five patients aged between 12 and 33 years (26 male, 19 female) previously treated with fixed appliances were enrolled in the study. The patients were randomly allocated to three groups (15 per group). For each group a mandibular canine-to-canine retainer of 0.018 inch Dentaflex multi-stranded wire (Dentaurum) was prefabricated for each patient on a cast. The bonding procedure was identical, except for the method of positioning the wire during adhesive fixation: group A dental floss, group B a small prefabricated transfer tray of dental resin and group C the NdFeB magnet device. For each group, the time required for the complete bonding process was measured. Kruskal–Wallis and Wilcoxon–Mann–Whitney tests were used for group and pairwise comparisons, respectively.

The three methods required statistically significant different times ($P < 0.001$). The Wilcoxon–Mann–Whitney test revealed that wire positioning with the magnet device was significantly faster [4.98 minutes; standard deviation (SD) 0.68 minutes] than with dental floss (7.65 minutes, SD 1.14 minutes; $P = 0.0001$) or with transfer tray (5.75 minutes, SD 0.57 minutes; $P = 0.001$).

The NdFeB magnet device is a timesaving appliance for positioning a multi-stranded, canine-to-canine retainer during bonding when compared with dental floss and an individually prefabricated transfer tray.

## Introduction

After completion of active orthodontic treatment, preventing the recurrence of crowding in the mandibular anterior segment is of major importance. As has been shown by Little *et al.* (1981, 1988), long-term alignment is highly variable and largely unpredictable. Therefore, long-term retention is recommended (Little *et al.*, 1981, 1988; Sadowsky and Sakols, 1982).

Zachrisson (1977) was one of the first to propose the use of individually adjusted, multi-stranded wire bonded on the lingual surface of each tooth for long-term retention. However, failures of the bonded retainer are frequently a problem (Zachrrison, 1977, 1997; Bearn, 1995; Årtun *et al.*, 1997; Segner and Heinrici, 2000).

Some factors have been identified as being important for long-term success regarding the accuracy of fitting of the wire and the bonding procedure. Among others, a suitable positioning technique for application of the wire during the bonding process is necessary, in order to ensure a fast and reliable workflow. This reduces the likelihood of moisture contamination of the etched tooth surface, which is one of the most important factors causing early failure (Dahl and Zachrisson, 1991; Andrén *et al.*, 1998).

The aim of the present study was to evaluate if a newly developed device comprising neodymium–iron–boron (NdFeB) magnets would offer adequate support for wire positioning during bonding. Therefore, the bonding time was measured and compared with conventional techniques.

## Subjects and methods

Forty-five patients aged between 12 and 33 years (26 male, 19 female) previously treated with fixed appliances were enrolled in the study. Before participation, the patients were required to give their informed consent. The research was conducted according to the standards approved by the Ethical Committee of the Georg-August-University, Göttingen (Vote Number 8/12/06). Three study groups were formed to which the patients (15 per group) were randomly allocated. The same bonding procedure was used for each group, except for the method of placing the wire on the lingual surface for adhesive fixation. After removal of the fixed appliance, an alginate impression (Blueprint cremix, Dentsply, Konstanz, Germany) of the lower dentition was taken. A canine-to-canine [0.018 inch Dentaflex multi-stranded wire (Dentaurum, Ispringen, Germany)] retainer was prefabricated by the same technician on the plaster cast. For adhesive fixation of the retainer, the lingual surfaces of the teeth were acid etched with 35 per cent phosphoric acid for 20 seconds, rinsed with water, and dried with dry, oil-free compressed air. Before etching, a lip retractor was inserted. Subsequently, Transbond XT primer (3M Unitek, Monrovia, California, USA) was applied with a brush on each tooth and then light cured (Astralis 5, Vivadent, Liechtenstein, Austria) for 20 seconds. The bonding procedure was performed in all three groups by the same orthodontist (WH) and in the same manner. After positioning the retainer, flowable composite Transbond LR (3M Unitek) was applied to each tooth, to cover the wire, and light cured for 20 seconds. Measurement of the time taken started with checking the fit of the retainer and ended after fixation, when all positioning appliances were removed.

In group A, the fit of the wire was controlled by holding the retainer to the lingual surfaces of the teeth with tweezers and fingers. Afterwards, each tooth was etched and bonded as described above, a strand of dental floss was then inserted between the contact surfaces of the central and lateral incisor on each side, in a manner producing two vertically orientated loops on the lingual side (Figure 1a). Afterwards, the retainer was threaded through the loops and positioned in relation to the lingual surfaces of the teeth by pulling the ends of the floss strands (Figure 1b). It was then fixed with flowable composite. Finally, the floss strands were removed by pulling them away in a lingual direction.

In group B, the retainer was prefabricated as for group A and, additionally, a small transfer tray of dental resin (Vita VM, Vita Zahnfabrik H. Rauter GmbH & Co. KG, Bad Säckingen, Germany), located between the central incisors, was applied (Figure 2a). The retainer fit was checked by positioning the wire on the teeth with the aid of the transfer tray (Figure 2b). Next, the adhesive fixation process was carried out as for group A up to the point when the composite was light cured. The wire was then positioned on the teeth with the transfer tray and the composite was applied on every tooth, to cover the wire, and each tooth was light cured for 20 seconds. Finally, the transfer tray was broken away from the wire.

For group C, a NdFeB magnet device was used for wire positioning. Three NdFeB magnets (2 cylinder 7 × 3 mm, NdFeB covered with nickel, 1.32 Tesla, and 1 cylinder 5 × 2 mm, NdFeB covered with nickel, 1.29 Tesla, Neotexx, Berlin, Germany) were lagged with conventional dental resin (Weitur-Press, Johannes Weithas, Lütjenburg, Germany) and subsequently connected by individually produced chains made from orthodontic wire which could not be magnetized. This magnet chain was prepared for the adhesive procedure by pressing it in a strand of wax (Surgident Periphery Wax, Heraeus Kulzer, Hanau, Germany) for positioning on the vestibular incisor surface. In group C, the time measurement started with positioning of the magnet chain on the teeth. After degreasing from canine to canine with 80 per cent alcohol, the chain was fixed with the wax strand on the buccal surfaces of the teeth (Figure 3a). The fit of the wire was controlled by holding the retainer near to the lingual surfaces of the teeth with forceps. The wire was adducted on the lingual surfaces by the magnetic field and could be adjusted to an ideal position using resin-made

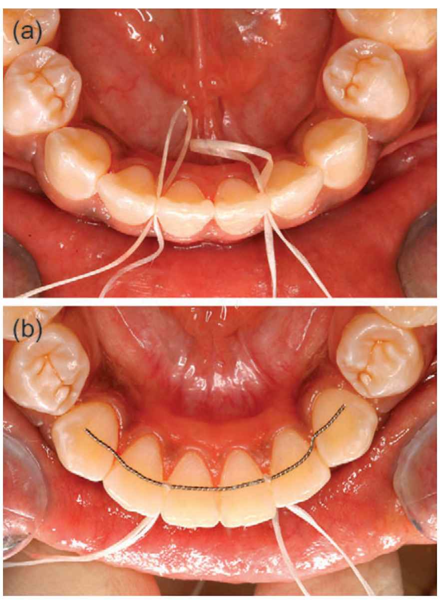


**Figure 1** Dental floss between lower incisors (a) positioning of the retainer with dental floss (b).

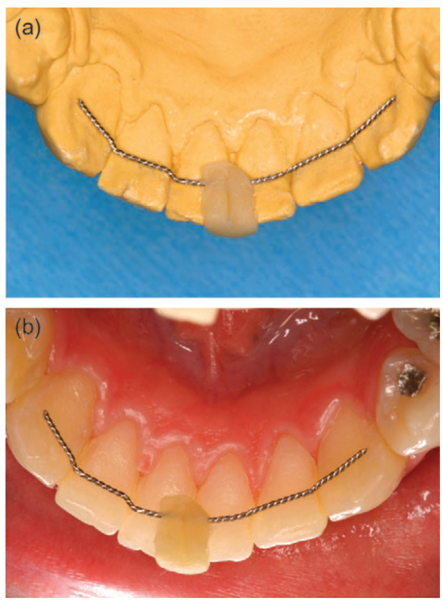


**Figure 2** Prefabricated retainer with transfer tray (a) checking the retainer fit with the transfer tray (b).

instruments (Figure 3b). After removing the retainer, the bonding procedure was conducted as described for group A, up to the point when the adhesive was light cured. The retainer was then adducted to the teeth with tweezers and held in place by the magnetic field alone. Composite was then applied on every tooth, to cover the wire, and each tooth was light cured for 20 seconds. Finally, the magnet chain was detached from the buccal surfaces of the teeth.

*Statistical analysis*

Data were analyzed using SAS 9.1 software (SAS Institute Inc., Cary, North Carolina, USA). For overall comparison of the three methods, a Kruskal–Wallis test was used and, for pairwise comparisons, the Wilcoxon–Mann–Whitney test.

## Results

The three methods required statistically significant different times ($P < 0.001$, Figure 4). The Wilcoxon–Mann–Whitney test showed that wire positioning with the magnet device was significantly faster [4.98 minutes; standard deviation (SD) 0.68 minutes] than with dental floss (7.65 minutes, SD 1.14 minutes; $P = 0.0001$) or with transfer tray (5.75 minutes, SD 0.57 minutes; $P = 0.001$, Table 1).

## Discussion

NdFeB magnets allow small shapes and sizes to be achieved and have many diverse uses in science, engineering, and industry. They have exceptionally strong magnetic properties, with even better resistance to demagnetization (Kirchmayr, 1996).

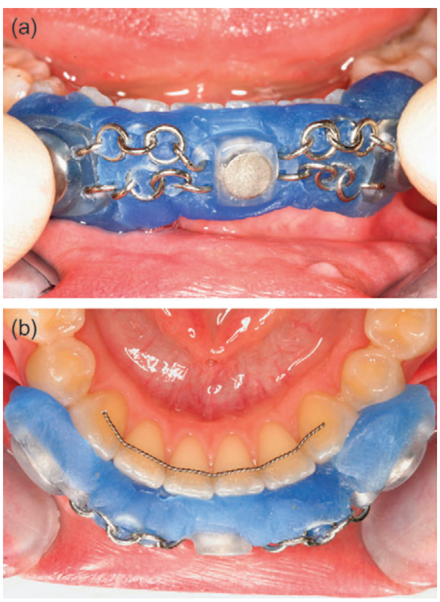


**Figure 3** Positioning of the magnet chain (a) checking the retainer fit with the magnet chain.

NdFeB magnets have been utilized previously for a number of different applications in orthodontic therapy (Joho and Darendeliler, 1991; Sandler, 1991; Darendeliler *et al.*, 1993), but never for positioning multi-stranded wire retainers.

Various authors have referred to the importance of working speed and a clear field of work to ensure the long-term success of bonded canine-to-canine retainers (Zachrisson, 1982; Dahl and Zachrisson, 1991; Andrén *et al.*, 1998). This is particularly important in relation to avoiding contamination of the etched tooth surfaces with saliva, blood, and sulcus fluid. The present results show, with the aid of a magnet chain, statistically significant faster adhesion compared with the use of dental floss ($P = 0.0001$) and opposite positioning with a transfer tray ($P = 0.001$) is possible. The gain in time was due to several factors. It was achieved, as a result of the possibility of feeding the composite into all six bonding points in a single work cycle. When loops of dental floss or a transfer tray were used, this resulted in them coming near to the adhesive fixation field. Because of this, it was sometimes not possible to apply the composite on all teeth together in groups A and B (Figure 3a). This resulted in a slower rate of working since contact has to be avoided between the composite and the dental floss or transfer tray.

The second reason for the longer adhesive fixation time was the difficulty in removing the dental floss and transfer

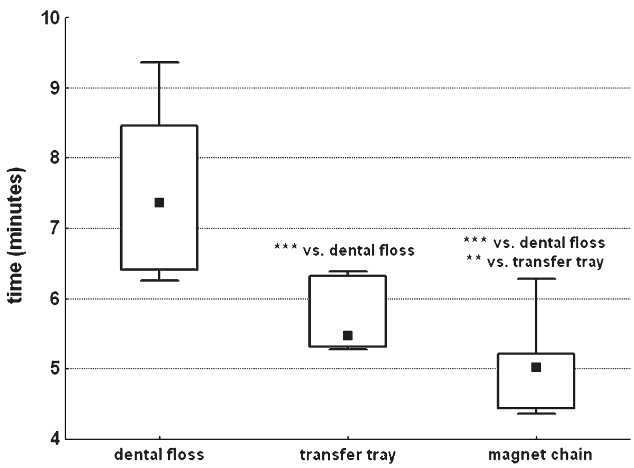


**Figure 4** Bonding time for the three different methods used: dental floss, transfer tray, and magnet chain.

**Table 1:** Significance of the comparisons between bonding times for the three methods: 1 dental floss, 2 transfer tray, and 3 magnet chain.

| Test | *P* value | Procedure |
|---|---|---|
| 1 versus 2 versus 3 | <0.001 | Kruskal–Wallis |
| 1 versus 2 | 0.0003 | Mann–Whitney *U*-test |
| 1 versus 3 | 0.0001 | Mann–Whitney *U*-test |
| 2 versus 3 | 0.001 | Mann–Whitney *U*-test |

tray after light curing the composite. In particular, when using dental floss, the control of fitting accuracy, the positioning of the dental floss, and threading and aligning the wire are a time-consuming process, which explains the long period needed for adhesive fixation compared with the two other methods.

When dental floss is used, this may cause bleeding, by irritating the gingiva. This constitutes a risk in terms of potential contamination of the surfaces on which the retainer is to be adhesively fixed. When magnetic chains are used, this is not possible since there is no mechanical irritation of the gingiva at any time. Transfer trays, for example, those made of an impression material such as silicone (Bantleon and Droschl, 1988; Haydar and Haydar, 2001), which cover the lingual surfaces of the teeth, prevent contamination from saliva, but do not allow control of the entry of liquid by capillary action through the gap between tray and tooth surface. The magnet can be simply taken off the tooth surface following adhesive fixation of the retainer; the wax residues can be easily brushed off and cleaning of the magnetic chain can be carried out by manually removing wax residues. It can then be disinfected with a thermo-disinfecting device and welded. Because of the low heat-resistant properties of the plastic coating, as is the case with all other laboratory produced transfer aids, sterilization is not possible. According to the information provided by the manufacturer, the neodymium magnets used must not be placed in the vicinity of storage media with magnetic strips or floppy disks. In addition, the magnets should not be used in subjects who have cardiac pacemakers (Li, 2007; Wolber *et al.*, 2007).

Since the average cost of materials is low (e.g. a magnet costs only 10 cents), the cost of an industrially manufactured magnet chain will not be very high. Also, the chains can be used over many years because of the durability of the NdFeB magnets (Kirchmayr, 1996).

## Conclusions

With the aid of a NdFeB magnetic chain, temporary, fast, and easy positioning of a retainer wire during bonding is possible. It is a favourable alternative to other positioning aids.

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