Examination of the Retention of Sm-Co5 and Nd-Fe-B Magnets

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Summary

When planning retention one of the most important tasks is to ensure that the construction, size and form of the retentive elements enable the transfer of forces which the loaded tissues can accept without damage. The use of magnets fabricated from biocompatible materials is becoming increasingly used as a means of retention for total and partial prosthetic replacements and resectional prostheses. The purpose of this study was to examine factors on which the strength of retentive forces Sm-Co5 and Nd-Fe-B magnets depend. The samples were divided into two groups: 28 pairs of Sm-Co5 magnets and 28 pairs of Nd-Fe-B magnets. The heights of the measured magnets were 2, 2.5 and 3 mm. Each sample consisted of a group with lateral force and a group without lateral force. The force values were measured by means of a device for measuring magnetic retentive forces, which enables the measurement of retentive forces of different combinations of permanent magnets and ferromagnetic materials. The results are presented in figures and tables. The basic factors that influence the magnitude of the retentive magnetic force are the type of magnet, size, their mutual distance and the presence of lateral forces. The values obtained indicate which sizes and thickness of the magnetic pairs should be used for the desired force of retention.

Key words: *retention, Sm-Co5 and Nd-Fe-B magnets.*

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Introduction

Conventional means of retention for total, partial and resection? prostheses, such as clasps, bars, telescopic crowns and attachments, are still the most frequently used means of retention today (1-3). Magnets for retention in the oral cavity provide a simple, acceptable and effective solution (4-12). Magnets for application in the oral cavity must be constructed of biocompatible materials and have appropriate magnetic force (13-14). Today such magnets are generally Sm-Co and Nd-Fe-B magnetic alloys, which possess better characteristics than other magnets and represent a significant advance for removable dentures (15). Magnetic elements located in the tooth root are most frequently used

with the corresponding magnetic alloy of the opposite field in the denture. Problems connected with magnetic retention occur due to corrosion, the existence of lateral forces, loss of the last abutment teeth and loose intraosteal implants (1-15).

The technical construction must be optimally incorporated into individual functional activities. One of the most important tasks when planning retention is to ensure that the construction, size and form of the retentive elements enable the transfer of force which the loaded tissues can accept without damage (16).

The aim of this study was to examine the factors on which the strength of the retentive force of Sm--Co5 and Nd-Fe-B magnets depends.

Materials and methods

The study was performed on a sample of 28 pairs of Sm-Co5 magnets and a sample of 28 Nd-Fe-B magnets. The diameter of the examined magnets amounted to 3, 4.5 and 6 mm, and the height 2, 2.5 and 3 mm.

The values of the retentive force were measured always between two Sm-Co5 magnets of the same or different dimensions and always between two Nd-Fe-B magnets of the same or different dimensions (Figure 1).

Each sample consisted of a group with lateral force and a group without lateral force.

All the samples were undamaged, accurately recorded diameters, heights and widths, and prepared in the Clinical Department of Dental Prosthetics Clinical Hospital Dubrava and the Dental Technical Laboratory Clinical Hospital Dubrava (17-19).

Apparatus

The apparatus for measuring retentive force must enable measurement and obtainment of values between two permanent magnets for different distances and positions, and enable measurement of the retentive force of different combinations of permanent magnets and ferromagnetic materials by which the concentrations of the magnetic flow/current and increase in retentive force are achieved. Retentive force was measured on a "Magnetic Dynamometer" apparatus at the "Ruđer Bošković" Institute. The apparatus enables cyclic switching on and off and continuous measurement of retentive forces during the whole procedure, measurement of vertical and horizontal gaps and collection of data (Figure 2).

The basis of the method was to establish the relation for obtaining the measurable surfaces of the magnets in a mutually parallel position. Every other position essentially reduced the value of the retentive force. The following variables were measured in the total sample of 56 examined magnets:

- Diameter of the first examined magnet (Nd-Fe-B I)
- Diameter of the second examined magnet (Nd-Fe-B II)
- Diameter of the first examined magnet (Sm-Co5 I)
- Diameter of the second examined magnet (Sm-Co5 II)
- Height of the first examined magnet (Nd-Fe-B I)
- Height of the second examined magnet (Nd-Fe-B II)
- Height of the first examined magnet (Sm-Co5 I)
- Height of the second examined magnet (Sm-Co5 II)
- Mutual distance of the examined magnetic alloys
- Measurement without the presence of lateral forces
- Measurement with the presence of lateral forces

Results

Analysis of the data was performed by means of the programme for statistical analysis SPSS 10.0 for Windows. The following were calculated: arithmetic means (x), coefficient of standard error (Dx), value of variance (SIG2), standard deviation (SIG), minimal and maximal value (20).

Results of an analysis of data on quantitative analysis of the retentive force of two different

permanent magnets are presented in Figures 3 and 4 and Table 1.

Figure 3. - The dotted line shows the obtained values without the effect of lateral forces, the full line the total sample and the broken line the sample obtained when lateral forces effected the attractive force of the Sm-Co5 magnets

Figure 4. - The dotted line shows the obtained values without the effect of lateral forces, the full line the total sample and the broken line the sample obtained when lateral forces affected the attractive force of the examined magnets.

By comparing these distributions it can be seen that the sample on which lateral forces did not effect values, shows movement towards higher values. This Fig. also shows that the value of retentive force between the two examined magnets uniformly increases as the gap between them decreases.

The results shown in the table and figures describe the sample and the frequency of the studied variables of the described magnetic alloys. The study showed that the value of attractive force between the examined magnetic alloys Sm-Co5, average size 4.5 mm x 4.5 x 2.5 mm, amounted to 208 cN in the total sample. With a mutual gap of 0 mm the value of retentive force was 285 cN. The highest values were found for the sample without lateral forces which amounted to 308 cN. The value of retentive magnetic force between two Nd-Fe-B magnets, size 4.5 mm x 4.5 mm x 2.5 mm, amounted to 235 cN in the total sample. For the sample without lateral forces retention amounted to 340 cN.

Discussion

Today various magnetic systems are used (in the root of the tooth and dentures, in an implant, open and closed magnetic systems etc.).

Application of a magnetic alloy as a means of retention for removable prostheses can, on the basis of their size and mutual distances, precisely determine the value of those forces considered not having a harmful effect on the periodontium of the abutment tooth.

The force of retentive elements must be known because only then is it possible to prevent damage to the periodontium, which is susceptible to tensile forces, and to assume a decline in retention of the prosthetic work.

When measuring retentive force in the mouth it is difficult to determine the amount of retention from adhesion and valvular effect in relation to magnetic retention. In addition the gap between the magnetic alloys, of which one is located in the abutment of the retentive element and the other in the movable denture, constantly changes during mastication, due to the differences in the resilience of the mucous membrane in relation to the intrusion of the teeth.

On the basis of an examination of methods and results, presented in tables and figures, significant/great difference can be seen in the values of the retentive force of the magnets, depending on which alloy is used, the size of the mutual gap between the alloys and whether horizontal, i.e. lateral forces, act on the attractive, mutual, vertical force. According to the results of the study, the proximity of the two opposite fields should be increased in the case of magnets with small surfaces. The dimensions of similar sized teeth were examined, so that the results obtained in this study can be used when planning retentive force with the clinically given conditions of intermaxillary space and magnet size.

Conclusion

The basic factors which influence the magnitude of retentive magnetic force are the type of magnet, size, their mutual distance and the presence of lateral forces. The values obtained in this study can be used for determination of optimal retention in given clinical conditions.