

Orthopedic dentists are trying to solve the problem of prosthetics for dentitions with distal defects. Removable dentures with magnetic retainers are securely fixed in the oral cavity, but due to the lack of a stabilizing part are unstable under horizontal load.

The purpose of our work is to systematize latest studies of magnetic fixation of removable dentures, and to propose a new concept of magnetic fixation.

A comprehensive search of PubMed, ScienceDirect and Scopus was conducted to determine the methods of using magnets to fixate dentures in the oral cavity.

During the experimental studies of magnets of different shapes and magnetization, we found a little-known fact - self-centering of magnetic pairs.

Based on this fact, we proposed a new conceptual technical solution for magnetic fixation in telescopic joints, relocate magnetic pairs to the vertical arrangement.

A working model of a telescopic joint with a vertical arrangement of magnetic pairs was made.

When the matrix part is mounted on the patrix part, the magnets are placed clearly opposite each other with opposite poles. Two magnetic pairs with balanced force fields are formed. In each of these pairs, the maximum balanced magnetic fields are established, and disturbances in the magnetic equilibrium create a counteraction to external forces regardless of the direction of their action. When the external forces end, the magnetic pairs return to their upward position.

The introduction of the new concept of magnetic fixation of removable dentures proposed by us will contribute to the achievement of better quality prosthetics.

Key words: fixation of removable dentures, magnetic fixation, telescopic connection, nitinol, magnetisation, self-centring of magnetic pairs.

Connection of the publication with planned research works.

The work is a fragment of the research work «Individual approach to the rehabilitation of patients with pathology of the dentoalveolar system» (state registration number 0122U002533).

Introduction.

A concept (*Latin, perception*) is a system of views on a certain phenomenon; a way of understanding and interpreting certain phenomena, the fundamental idea of a theory, its general idea.

In the study of various types of denture fixation, it was found that since the beginning of the use of magnetic retainers in the telescopic connection between the denture and natural teeth or implants, only two functions were provided:

- support;
- retentive (retention) [1, 2, 3, 4].

As noted in the literature, the use of the so-called horizontal (occlusal) magnetic retainers also had advantages:

- permanent retention;
- axial load;
- activation is not required;
- no need for alignment of the supports;
- uncomplicated oral hygiene.

Removable dentures with magnetic attachment distribute the chewing load on the abutment teeth, are securely held in the oral cavity, but due to the absence of a stabilising part, they are unstable under horizontal load, and lateral (transverse) displacements of the denture base are possible. Overloading of the supporting objects, sharp atrophy of the alveolar ridges

led to restrictions for such magnetic retainers. The latter are used mainly as an auxiliary element [1, 5, 6, 7].

According to various researchers, the mucous membrane's pliability is 10-50 times greater than the natural mobility of the abutment tooth.

Therefore, when a removable denture is rigidly fixed to the abutment teeth, the base of these dentures can make micromovements under the influence of masticatory pressure to the extent of the mucous membrane's compliance. In this case, most of the load is transferred through the rigid attachment to the abutment teeth, and a «cantilever» effect can be created, which is expressed in the tilt of the abutment teeth towards the defect.

Therefore, the main goal in the treatment of dentitions with distal defects is to achieve an even distribution of the chewing load between the mucosa of the prosthetic bed and the periodontium of the abutment teeth.

Since partial dentures are based on biologically heterogeneous structures, they must compensate for potential differences in pressure transfer to the tissues and help maintain their normal functional state [8].

The problem of prosthetics of distal defects in the dentition remains relevant today. Prosthodontists have been trying to solve this problem for a long time, developing various designs that would, firstly, reduce the vertical load on the alveolar ridge, secondly, distribute it evenly over the entire alveolar ridge and, thirdly, rationally distribute it over the entire prosthetic bed. The main focus is on finding the optimal type of attachment of the removable denture [9].

Throughout the existence of removable dentures, scientists have been trying to develop a method of

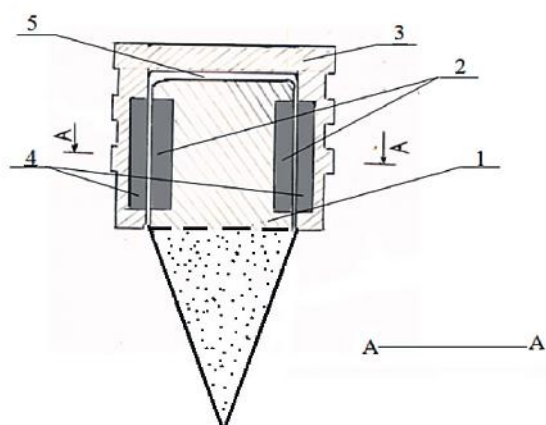


Figure 1 – Schematic representation of the general view of the proposed telescopic connection, where: 1 – «patrix»; 2 – permanent magnets of «patrix»; 3 – «matrix»; 4 – permanent magnets of «matrix»; 5 – occlusal gap.

attaching the removable part of the denture to the abutment teeth that would eliminate the «cantilever» effect, which is only possible when a strong connection between the removable and fixed parts is eliminated.

Basic properties of permanent magnets:

- the magnetic effect of a magnet is strongest near its poles;
- the magnetic effect of a permanent magnet is different in different parts of its surface; those parts of the magnet's surface where the magnetic effect is strongest are called the poles of the magnet;
- the poles of the same name repel each other, and the poles of different names attract each other;
- the magnet has a north N and south S pole;

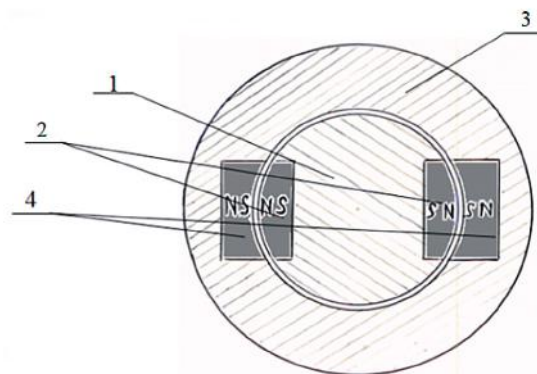


Figure 2 – Schematic representation of a general view of the proposed telescopic connection in the section at the level of the centers of the magnets, where: 1 – «patrix»; 2 – permanent magnets of «patrix»; 3 – «matrix»; 4 – permanent magnets of «matrix».

It is impossible to produce a magnet with only one pole;

- when a permanent magnet is heated to a certain temperature (Curie point), its magnetic properties disappear [6, 7].

The aim of the study.

Based on the sources of scientific and medical information, to systematize the authors' views on the role and importance of magnetic fixation of dentures. Determine the optimal type of denture attachment and propose a new concept of magnetic fixation.

Object and research methods.

A comprehensive search was conducted in PubMed, ScienceDirect and Scopus to determine the methods



Figure 3 – 3D printer Asiga MAX UV.



Figure 4 – Liquecreate Bio-Med Clear is a biocompatible resin material for 3D printing.

of using magnets to fix dentures in the oral cavity. As a result of the analytical processing of scientific and medical sources, it was found that only such properties of magnets as attraction and adhesion with the axial form of magnetization of these magnets were used for dentures fixation [4, 10].

During the experimental and laboratory studies of magnets of different shapes, magnetization and materials, we have established a little-known fact – self-centering of magnetic pairs, or «the property of returning to the upward position after the external force is stopped», or «the effect of magnetic location memory», similar to the use of nitinol metal with the effect of shape memory in dentistry. Objects made of nitinol (titanium nickelide), an alloy of titanium and nickel, are able to «remember» their original shape and return to it when subjected to temperature effects [11].

Research results and their discussion.

Based on the established fact, we proposed a new conceptual technical solution for magnetic fixation in telescopic joints (beam system, attachments, telescopic crowns, etc.), namely, in contrast to the generally accepted horizontal (occlusal) arrangement of magnetic pairs, to transfer them to the vertical (apical) one, [12, 13] see fig. 1.

Fig. 2 schematically shows a general view of the proposed telescopic connection in the section at the level of the centers of the magnets.

In order to achieve this goal, it was necessary to conduct experimental studies to prove the efficiency of the new technical solution.

The experimental studies consisted in making a working model of a telescopic connection with a vertical arrangement of magnetic pairs and applying a certain force (1N-5N) to the matrix in different directions – vertical, sagittal, transverse and rotational, corresponding to the physiological mobility of a natural tooth.

Manufacturing of the working model and experimental study was carried out at MIX-Lab PE, license of the Ministry of Health of Ukraine, series AE No. 459333 dated 07.08.2014.

The CAD/CAM system was used to model and manufacture the components of the telescopic joint «patrx» and «matrix».

The modeling was carried out in the program ZIRKONZAHN. Modellier 9539 (2020-09-28).

The constituent elements were manufactured on a 3D printer (fig. 3) using 3D printing materials (figs. 4, 5) similar to the method of manufacturing double crowns of a cylindrical shape of a conventional telescopic joint, the peculiarity is that on the side surfaces of the constituent elements formed recesses in which permanent neodymium magnets were fixed.

The optimal parameters of magnetic pairs were determined by physical modeling,



Figure 5 – Asiga DentaMODEL – material for 3D printing dental models.

and the retention forces of removable laminar dentures were calculated.

When the matrix part is installed on the patrx part, the magnets are positioned exactly opposite each other with opposite poles. Two magnetic pairs with balanced force fields are formed. In each of these pairs, the maximum balanced force magnetic fields are established, and violations of the magnetic equilibrium create a counteraction to external forces regardless of the direction of their action (fig. 6).

When the external forces cease, the magnetic pairs return to their upward position. The mechanism of magnetic balance is essentially similar to the work of the periodontal ligament of a natural tooth.

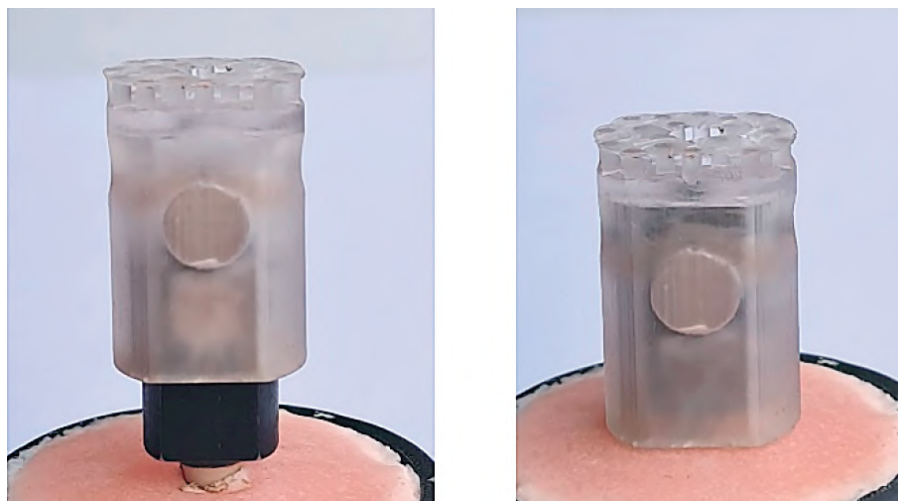


Figure 6 – Telescopic connection with vertical arrangement of magnetic clamps.

Thus, removable dentures with a vertical arrangement of magnetic retainers provide the necessary functions in the oral cavity: fixing, supporting, redistributing, stabilizing and cushioning.

As a result of experimental and laboratory studies, it was also found that the functionality of denture fixation depends on the magnetic components (pairs) according to the following parameters:

- magnetization;
- size (area, volume);
- coercive force;
- topographic location;
- geometric shape;
- combination of geometric shapes
- magnetic pair distance (intermagnetic space);
- direction of magnetization;
- magnetic material

• balance of the magnetic field between magnetic pairs.

Taking into account the established dependencies, there is a need for their further deep and thorough scientific study and research for the use of the proposed magnetic compound in clinical practice.

Conclusions.

The perception and implementation of the new concept of magnetic fixation of removable dentures proposed by us will contribute to the achievement of a higher and more effective level of prosthetics and better restoration of dental health.

Prospects for future research.

The production of magnetic fixation devices developed by us will enable us to manufacture innovative and diverse dental products and compete with other fixation devices.

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НОВА КОНЦЕПЦІЯ МАГНІТНОЇ ФІКСАЦІЇ В СТОМАТОЛОГІЇ

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Резюме. Проблема протезування кінцевих дефектів зубних рядів залишається актуальною і на сьогоднішній день. Лікарі стоматологи – ортопеди давно намагаються вирішити цю проблему, розробляючи різні конструкції. Основна увага при цьому направлена на пошук оптимального виду кріплення знімного протеза.

Знімні протези з магнітним кріпленням розподіляють жувальне навантаження на опорні зуби, надійно утримуються в порожнині рота, але із-за відсутності стабілізуючої частини нестійкі при горизонтальному навантаженні, можливі бокові (трансверзальні) зміщення базису протеза.

Перевантаження опорних об'єктів, різка атрофія альвеолярних гребенів спонукала обмеженню для таких магнітних фіксаторів. Останні використовують в основному, як допоміжний елемент.

Мета дослідження. На основі джерел науково-медичної інформації систематизувати погляди авторів на роль та значення магнітної фіксації зубних протезів.

Визначити оптимальний вид кріплення зубних протезів та запропонувати нову концепцію магнітної фіксації.

Об'єкт і методи. При проведенні експериментально-лабораторних досліджень магнітів різних форм, намагніченності та матеріалів нами було встановлено маловідомий факт – самоцентрування магнітних пар, або «властивість повертатися у висхідне положення після припинення дії зовнішньої сили», або «ефекту магнітної пам'яті розташування», аналогічно використанню в стоматології нітінолу металу з ефектом пам'яті форми. Предмети з нітінолу (нікелід титану) – сплаву титану і нікелю – здатні «запам'ятовувати» первісну форму і повертатися до неї при використанні температурного впливу.

На підставі встановленого факту, нами було запропоновано нове концептуальне технічне рішення магнітної фіксації у телескопічно-подібних з'єднаннях (балочна система, атачмени, телескопічні коронки та інші), а

саме, на відміну від загально прийнятого горизонтального (оклюзійного) розташування магнітних пар перенести їх на вертикальне (апроксимальне).

Результати. В результаті експериментальних досліджень телескопічного з'єднання показали спроможність магнітної системи забезпечити всі необхідні функції знімним зубним протезам, а саме: фіксуючу, опорну, перерозподільчу, стабілізуючу та амортизуючу.

Висновки. Сприйняття та впровадження запропонованої нами нової концепції магнітної фіксації знімних зубних протезів сприятиме досягненню вищого та ефективного рівня протезування та більш якісного відновлення стоматологічного здоров'я.

Ключові слова: фіксація знімних протезів, магнітна фіксація, телескопічне з'єднання, нітінол, намагніченість, самоцентрування магнітних пар.

NEW CONCEPT OF MAGNETIC FIXATION IN DENTISTRY

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Abstract. The problem of prosthetics of distal defects in the dentition remains relevant today. Prosthodontists have been trying to solve this problem for a long time, developing various designs that would. The main focus is on finding the optimal type of attachment for the removable denture.

Removable dentures with magnetic attachment distribute the chewing load on the abutment teeth, are securely held in the oral cavity, but due to the absence of a stabilising part, they are unstable under horizontal load, and lateral (transverse) displacements of the denture base are possible. Overloading of the supporting objects, sharp atrophy of the alveolar ridges led to restrictions for such magnetic retainers. The latter are used mainly as an auxiliary element.

The aim of work. Based on the sources of scientific and medical information, to systematize the authors' views on the role and importance of magnetic fixation of dentures.

Determine the optimal type of denture attachment and propose a new concept of magnetic fixation.

Object and methods. During the experimental and laboratory studies of magnets of various shapes, magnetization and materials, we have established a little-known fact – self-centering of magnetic pairs, or «the property of returning to the upward position after the external force is stopped», or «magnetic location memory effect», similar to the use of nitinol in dentistry, a metal with a shape memory effect. Objects made of nitinol (titanium nickelide), an alloy of titanium and nickel, are able to «remember» their original shape and return to it when subjected to temperature.

Based on the established fact, we proposed a new conceptual technical solution for magnetic fixation in telescopic joints (beam system, attachments, telescopic crowns, etc.), namely, in contrast to the generally accepted horizontal (occlusal) location of magnetic pairs, to transfer them to the vertical (apical) one.

Results. Experimental studies of the telescopic connection have shown the ability of the magnetic system to provide all the necessary functions for removable dentures, namely: fixing, supporting, redistributing, stabilizing and cushioning.

Conclusions. The perception and implementation of the new concept of magnetic fixation of removable dentures proposed by us will contribute to the achievement of a higher and more effective level of prosthetics and better restoration of dental health.

Key words: fixation of removable dentures, magnetic fixation, telescopic connection, nitinol, magnetisation, self-centring of magnetic pairs.

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Conflict of interest:

The Authors declare no conflict of interest.

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