ОРТОДОНТИЧНИЙ РОЗДІЛ

DOI 10.35220/2078-8916-2019-33-3-29-34

УДК: 616.314.26-089.843-039.74-035

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THE JUSTIFICATION FOR THE USE OF TEMPORARY DENTAL IMPLANTS AS A SKELETAL SUPPORT DURING ORTODONTIC TREATMENT OF PATIENTS WITH SECONDARY DEFORMATIONS OF DENTAL ROWS

Purpose of research. *The use of dental implants as an anchorage for orthodontic treatment causes the highest stresses in the bone tissue with a horizontal load compared to a vertical one. It is the horizontal load that can cause mobility and disintegration of the implant, cause resorption or necrosis of the bone around the implant. In the case of using a dental implant only for orthodontic treatment, it is better to use a one-stage technique. Then the implant can be loaded immediately after its installation, invasive procedures are reduced and aesthetic requirements are not taken into account.*

Materials and methods*. Since the intraosseous design and characteristics of OMG orthodontic mini-implants and VKtemp temporary dental implants are comparable, and the biomechanical characteristics of the bone-implant model should not differ significantly, in this regard, studies of the mechanical endurance of bones and implants under power load were carried out. There were 4 stages of experimental research: installation of implants at an angle of 15-20 degrees and 90 degrees to the plane of the body of the pig's rib and 1 kilogram-force (kgf) (9.8 N) and 2 kilogram-force (19.6 N) were used with horizontal and vertical load. 2 weeks after application of the load, visual inspection of the ribs (examination was carried out under an increase of 2.5 and 3.5 times) revealed no changes in the bone around the implants.*

Summary*. The implants did not change their initial position, were motionless and stable. A comparative analysis of x-ray images of the bone tissue of the investigated rib samples made before and after loading did not reveal any morphological changes in the bone around the implants.*

Key words: *orthodontic mini-implant, temporary dental implant, secondary deformations of dental rows.*

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ОБГРУНТУВАННЯ ВИКОРИСТАННЯ ТИМЧАСОВИХ ДЕНТАЛЬНИХ ІМПЛАНТАТІВ В ЯКОСТІ СКЕЛЕТНОЇ ОПОРИ ПІД ЧАС ОРТОДОНТИЧНОГО ЛІКУВАННЯ ПАЦІЄНТІВ ІЗ ВТОРИННИМИ ДЕФОРМАЦІЯМИ ЗУБНИХ РЯДІВ

Мета*. Використання дентальних імплантатів, в якості анкоражу при ортодонтичному лікуванні, викликає найбільш високі напруження в кістковій тканині під час горизонтального навантаження, в порівнянні з вертикальним. Саме горизонтальне навантаження може викликати рухомість і дезінтеграцію імплантату, спричинити резорбцію або некроз кістки навколо імплантату. У випадку використання дентального імплантату лише для ортодонтичного лікування, краще застосовувати одноетапну методику. Тоді імплантат можна навантажувати відразу після його встановлення, зменшуються інвазивні втручання і не враховуються естетичні вимоги.*

Матеріали і методи. *Оскільки внутрішньокістковий дизайн і характеристики ортодонтичних мініімплантатів OMG і тимчасових дентальних імплантатів VKtemp порівняльні і біомеханічні характеристики моделі «кістка-імплантат» суттєво не повинні відрізнятись, тому були проведені дослідження механічної витривалості кістки і імплантатів при силовому навантажені. Було проведено 4 етапи експериментального дослідження: встановлення імплантатів під кутом 15-20 градусі і 90 градусів до площини тіла ребра свині і використані 1 кілограм-сили (кгс) (9.8 Н) і 2 кілограм-сили (19,6 Н) при горизонтальному і вертикальному навантажені. Через 2 тижні, після прикладання навантаження, при візуальному огляді ребер (огляд проводився під збільшенням у 2,5 і 3,5 разів) не виявлено змін кістки навколо імплантатів.*

Висновки*. Імплантати не змінили свого початкового положення, були нерухомі і стабільні. Порівняльний аналіз рентгенівських знімків кісткової тканини досліджуваних зразків ребер, зроблених до і після навантаження, морфологічних змін кістки навколо імплантатів не виявив.*

Ключові слова: *ортодонтичний мініімплантат, дентальний тимчасовий імплантат, вторинні деформації зубних рядів.*

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ОБОСНОВАНИЕ ИСПОЛЬЗОВАНИЯ ВРЕМЕННЫХ ДЕНТАЛЬНЫХ ИМПЛАНТАТОВ В КАЧЕСТВЕ СКЕЛЕТНОЙ ОПОРЫ ВО ВРЕМЯ ОРТОДОНТИЧЕСКОГО ЛЕЧЕНИЯ ПАЦИЕНТОВ С ВТОРИЧНЫМИ ДЕФОРМАЦИЯМИ РЯДОВ

Цель. Использование дентальных имплантатов, в качестве *анкоража при ортодонтическом лечении, вызывает наиболее высокие напряжения в костной ткани при горизонтальной нагрузке, по сравнению с вертикальной. Именно горизонтальная нагрузка может вызвать подвижность и дезинтеграцию имплантата, вызвать резорбцию или некроз кости вокруг имплантата. В случае использования дентального имплантата только для ортодонтического лечения, лучше применять одноэтапную методику. Тогда имплантат можно нагружать сразу после его установки, уменьшаются инвазивные вмешательства и не учитываются эстетические требования.*

Материалы и методы. *Поскольку внутрикостный дизайн и характеристики ортодонтических миниимплантатов OMG и временных дентальных имплантатов VKtemp сравнимы, и биомеханические характеристики модели «кость-имплантат» существенно не должны отличаться, в связи с этим были проведены исследования механической выносливости кости и имплантатов при силовой нагрузке. Было проведено 4 этапа экспериментального исследования: установка имплантатов под углом 15-20 градусов и 90 градусов к плоскости тела ребра свиньи и использованы 1 килограмм-силы (кгс) (9.8 Н) и 2 килограмм-силы (19,6 Н) при горизонтальной и вертикальной нагрузке. Через 2 недели после приложения нагрузки, при визуальном осмотре ребер (осмотр проводился под увеличением в 2,5 и 3,5 раза) не выявлено изменений кости вокруг имплантатов.*

Выводы. *Имплантаты не изменили своего первоначального положения, были неподвижны и стабильны. Сравнительный анализ рентгеновских снимков костной ткани исследуемых образцов ребер, сделанных до и после нагрузки, морфологических изменений кости вокруг имплантатов не обнаружил.*

Ключевые слова: *ортодонтические миниимплантаты, временные дентальные имплантаты, вторичные деформации зубных рядов.*

Introduction. Analysis of scientific publications shows that the overall success of the use of mini-implants as an additional skeletal support during orthodontic treatment of dental malformations and deformities ranges from 70.0% to 87.0%, and the largest amount of loss of the mini-screws (90%) occurred during the first four months of their use. Loss or rejection of the orthodontic mini-implant does not cause irreversible changes, predominantly a different implant is installed, which does not require changing the treatment plan [1-10].

However, the use of dental implants as anchorage in orthodontic treatment causes the highest stresses in bone tissue during horizontal loading compared to vertical. Horizontal loading can cause mobility and disintegration of the implant, cause bone resorption or necrosis around the implant. [11, 12]. When using a dental implant only for orthodontic treatment, it is better to use a one-step technique. Then the implant can be loaded immediately after its installation, invasive procedures are reduced and aesthetic requirements are not taken into account [13].

The aim of the research. To study the endurance of the bone under the effect of horizontal and vertical loading using temporary dental implants as an additional skeletal support in the orthodontic treatment of secondary deformities caused by defects of the dental rows.

Materials and methods. The comparative assessment of the designs of domestic orthodontic mini-implants "OMG" and temporary dental implants VKtemp. Raw pig ribs were used to evaluate bone endurance (fig.1). Four stages of the experimental study were conducted. At the I stage, two temporary dental VKtemp implants with a diameter of 2.5 mm and a length of 10 mm were installed on the upper surface of the body (corpus costae) of the raw pig rib, at an angle of 15-20 degrees to the plane of the rib body.

At the II stage a temporary VKtemp dental implant with a diameter of 2.5 mm and a length of 10 mm was installed on the upper surface of the body (corpus costae) of the raw rib of the pig, at an angle of 90 degrees to the plane of the rib body:

At the III stage on the upper surface of the body (corpus costae) of the raw pig rib, at an angle of 15-20 degrees to the plane of the rib body were installed two mini- implants "OMG" with a diameter of 1.8 mm and a length of 10 mm.

At stage IV, a temporary dental implant of 1.8 mm diameter and 10 mm length was installed on the upper surface of the body (corpus costae) of the raw pig rib, at an angle of 90 degrees to the plane of the rib body.

In stages I and III, implants on one side of the rib were attached with floss to the tripod. On the opposite side, a 1 kg weight was attached to the implants. Thus, lateral "pulling out" force acted on one implant, and lateral "dislocating" force acted on the other. For 2 weeks, the raw pig rib was in the hanging position, attached to the tripod by implants, withstanding a load of 1 kilogram (9.8 N).

In the II and IV stages, the pig rib with the implant with the help of dental floss is suspended horizontally from below the tripod. A 2 kg weight is attached to the implant, which is located in the middle of the lateral surface of the rib body. Within 2 weeks, the rib was in a horizontal position and the implant was subjected to a vertical force of 2 kilograms (19.6 H).

To prevent bone overheating during drilling, the speed of rotation of the boron was limited from 800 to 1000 rpm. When using temporary dental implants VKtemp a drill with a diameter of 2.0 mm was used. For the installation of OMG mini-implants - drill 1.0 mm.

Results and discussion. The domestic system of orthodontic mini-implants “OMG” includes several types of mini-implants and tools for their installation [14].

Mini-implant "OMG" consists of intraosseous, gingival (neck) and supragingival (head) parts. The intraosseous part has a diameter of 1.3 mm, 1.6 mm or 1.8 mm and a length of 6, 8 or 10 mm (fig. 1.).

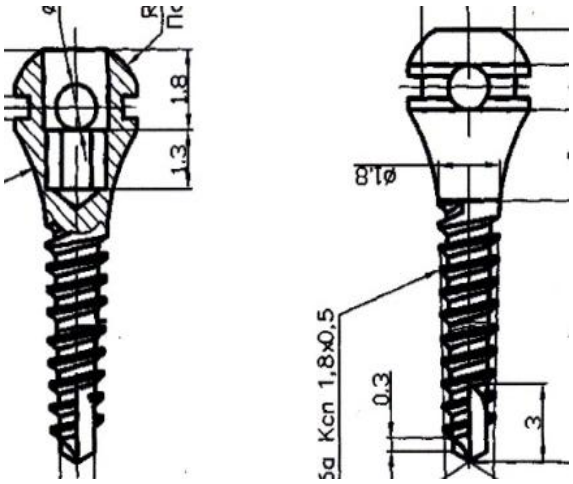

Fig. 1. Scheme of the OMG mini-implant (Rivis O.M.).

The shape of the mini-implant, starting from the neck, is trapezoidal with a tilt angle of 15°. The microporous (9-12 micron) surface of the threaded part provides partial osteointegration, which helps to improve the stability of the mini-implant throughout its period of use. The possibility of choosing the length and diameter of the intraosseous part makes it possible to install mini-implants in almost any part of the alveolar ridge or between the roots of adjacent teeth. A special screwdriver and standard quadrilateral drill with a thickness of 1.0 mm are used to install the mini-implant. Mini-implants are in sterile packaging and do not require pre-sterilization [16].

VKtemp dental implant is a temporary single-component implant with an external tetrahedron from the national manufacturer VITAPLANT®. This implant is used to support temporary cementitious structures at the stages of waiting for osseointegration of permanent implants (fig. 2).

Fig. 2. Implant VKtemp VITAPLANT®.

The method of processing the entire surface of the implant: acid etching. The root-shaped implant and the 15-degree angle of the thread ensure uniform distribution of the functional load vectors. The biconcave neck contributes to the displacement of the wound channel of the mucosa in relation to the bone. The diameter is 2.5 mm and the length is 10 mm, 12 mm, 14 mm or 16 mm. Depending on the type of bone, pilot drills with a diameter of 2.0 mm and 1.5 mm are used, both classical implantation and transgingival (without an incision) are possible.

Thus, comparing the characteristics of OMG orthodontic mini implants and temporary one-component dental implants VKtemp**:** implant shape, diameter (OMG - 1.3-1.8 mm; VKtemp - 2.5 mm), thread angle (same - 15 degrees), length (OMG - 6.0-10.0 mm; VKtemp – 10.0 – 16.0 mm) we assumed that VKtemp implants could be successfully used as skeletal support in the area of prematurely lost teeth during orthodontic treatment of secondary dentition deformities (table).

Table

Comparative characteristics of OMG orthodontic mini-implants and VKtemp temporary dental implants

Implants	Form of implants	The diameter of the implants, mm	Implant thread angle	Implant length, mm
OMG	Root-shaped	1.3, 1.6, 1.8	15°	6, 8, 10
VKtemp	Root-shaped	2.5	15°	10, 12, 14, 16

Rivis O. Yu. [15] in order to study the biomechanical characteristics of the OMG mini-implant, comparing it with other mini-implants under orthodontic load, substantiating the location and direction of the mini-implant placement to ensure movement of the teeth, used mathematical modeling methods (finite element method). To conduct the study, a simulation computer model of the bone-mini-implant biomechanical system was developed.

By the method of mathematical modeling, it was found that under the force load of the "bone-mini-implant" biomechanical system, the stress concentration zone is located in the cortical plate region and does not depend on the type of mini-implant design. The greater the thickness of the cortical bone layer, the greater the load the mini-implant can withstand. The maximum supportability of bone tissue to the orthodontic load is observed for a tilt angle of mini-implants of 90˚ to the surface of the cortical plate (Rivis O. Yu., 2017 [15]).

Since the intraosseous design and characteristics of OMG mini-implants and VKtemp temporary dental implants are comparative, we assumed that the biomechanical characteristics of the bone-mini-implant model should not differ significantly, therefore, studies of the mechanical endurance of bones and implants under force-load.

To conduct research on the possibility of using temporary dental implants VKtemp as a skeletal support, during the orthodontic treatment of secondary deformations of the dentition, raw pig ribs were used. (fig. 3).

We carried out 4 stages of experimental research: the installation of implants at an angle of 15-20 degrees and 90 degrees to the plane of the rib body and the use of 1 kilogram-force (kgf) (9.8 N) and 2 kilogram-force (19.6 N). An implant surgeon performed pilot openings and implant placement (fig. 4). To prevent bone overheating during drilling, the speed of rotation of the boron was limited from 800 to 1000 rpm. When using temporary dental VKtemp implants, a drill with a diameter of 2.0 mm was used. 1.0 mm drill bit for OMG implant placement. At I and III stages, 1 kilogram-force (9.8 N) was applied for 2 weeks, at II and IV stages for 2 weeks - 2 kilogram-force (19.6 N).

Fig. 3. Raw pig ribs are prepared for implant placement.

At stage I, on the upper surface of the body (corpus costae) of a raw pig rib, at an angle of 15-20 degrees to the plane of the rib body, two temporary VKtemp dental implants with a diameter of 2.5 mm and a length of 10 mm were installed.

At the II stage, a temporary dental implant VKtemp with a diameter of 2.5 mm and a length of 10 mm is installed on the upper surface of the body (corpus costae) of a raw pig rib, at an angle of 90 degrees to the plane of the rib body:

In stage III, two OMG mini implants with a diameter of 1.8 mm and a length of 10 mm were in-

stalled on the upper surface of the body (corpus costae) of a raw pig rib, at an angle of 15-20 degrees to the plane of the rib body.

At stage IV, a temporary OMG implant with a diameter of 1.8 mm and a length of 10 mm is installed on the upper surface of the body (corpus costae) of a raw pig rib, at an angle of 90 degrees to the plane of the rib body

а б

Fig. 4. Temporary dental implants (a) placement in pilot openings (b).

At stages I and III, the implants on one side of the rib were tied with dental floss to a tripod. On the opposite side, a weight of 1 kg was tied to the implants (Fig. 5, a). Thus, lateral “pulling out” force acted on one implant, and lateral “dislocating” force acted on the other. For 2 weeks, the raw pig rib was in the hanging position, attached to the tripod by implants, withstanding a load of 1 kilogram (9.8 N).

In stages II and IV, the pig rib with the implant is horizontally suspended from the tripod using dental floss. A weight of 2 kg is tied to the implant, which is installed in the middle of the lateral surface of the rib body, (Fig. 5, b). For 2 weeks, the rib was in a horizontal position, and a vertical force of 2 kilogram-force (19.6 N) acted on the implant.

a b

Fig. 5. Application of force with vertical (a - 1 kgf) and horizontal (b - 2 kgf) position of the rib.

2 weeks after application of the load, visual examination of the ribs (the inspection was conducted under an increase of 2.5 and 3.5 times) revealed no changes in the bone around the implants. The implants did not change their initial position and were motionless and stable.

A comparative analysis of x-ray images of the bone tissue of the investigated rib samples made before and after load did not reveal morphological changes in the bone around the implants.

We decided to continue the experiment for another 2 weeks, increasing the load to 2 kilogram-forces (19.6 N) with vertical load and up to 2.5 kilogram-forces (24.5 N) with horizontal load. Both visual examination and x-ray of the pig ribs showed no changes around the implants.

Findings. Given that the intraosseous design and characteristics of OMG mini-implants and VKtemp temporary dental implants are the same, except for the diameter (2.5 mm - VKtemp, 1.3-1.8 mm - OMG), we believe that VKtemp temporary dental implants can be used as an additional skeletal support during orthodontic treatment of secondary dentition deformities. The studies of mechanical endurance of the bone (raw pig ribs) and implants with horizontal and vertical load forces (9.8N, 19.9N and

24.5N) confirmed the stability of the implants and the integrity of the bone around them.

Conflict of interest: none.

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The article was received 14.08.19