

ORTHOPAEDIC TREATMENT ALGORITHM FOR PERIODONTAL DISEASE USING LOCK-FASTENING ON TEETH AND IMPLANTS

Odilkhon Salimov

Tashkent State Dental Institute, Uzbekistan e-mail: doc.salimov@mail.ru

Abstract: The developed algorithm of methods for planning orthopedic treatment of patients with partial loss of teeth, as well as the algorithm of general approaches to prosthetics in case of periodontal diseases created on the basis of these methods allowed to consider them as an expert system of support of clinical decision-making in planning orthopedic treatment and to use it for registration of possible changes in the process of dynamic observation of patients and, if necessary, to carry out conservative measures in time as well as to predict the outcome of the treatment.

Keywords: treatment algorithm; osseointegration; lock fasteners; implant; chronic generalized periodontitis; periodontosis;

Introduction: Inflammatory periodontal disease is one of the main causes of tooth loss. In some age groups the number of people with inflammatory periodontal disease reaches 80-100% [1,4,6,7].

For this category of patients, not only aesthetically advantageous prostheses are essential, but also the nature of the orthopedic structure - removable or fixed. Introduction of dental implantation into the rehabilitation process of this category of patients opens up new possibilities in treatment of patients with periodontal diseases [8,10,13,14,17].

Modern structures of removable prostheses do not solve the main task of treatment of patients with periodontal disease - rational distribution of chewing pressure [20,21,23,25]. Besides, the successes achieved in implantology do not solve the tasks of orthopedic treatment of this category of patients to the full extent, a number of issues related to planning of orthopedic treatment on artificial supports in patients suffering from periodontal disease remain unsolved. Further search for ways to improve the methods of implantation and choice of the most optimal orthopedic design will contribute to the efficiency of rehabilitation of this category of patients [18,19,22].

Development of new systems for fixation of removable dentures in case of partial loss of teeth will allow to improve the quality of prosthetic replacement of dental defects, to determine a unified standard of treatment based on the design features of the prosthesis that meets the requirements of functionality (increase in prosthesis stabilization), universality (use under different clinical conditions), reduction of functional overload, as well as aesthetics and economic efficiency [24,26,27].

Thus, at present there is an urgent need to use the results of clinical, morphological and biomechanical research to improve the efficiency of planning and orthopedic treatment of periodontal disease based on an integrative approach, to create an expert planning system, to improve tire structures - prostheses, to develop implants with a long life cycle, which in turn will improve the efficiency of rehabilitation of patients with generalized periodontal disease.

The aim of the research: to develop an algorithm of orthopedic treatment for periodontal disease with the use of lock fixation on natural teeth and implants.

Materials and methods of research: Under our supervision there were 300 patients with periodontal disease (Table 1) who applied to the Department of Orthopedic Dentistry of Tashkent State

Dental Institute (TSDI) for prosthetics. Current observations were received for 2014-2016. The comprehensive examination of patients included clinical, radiological and functional methods of investigation.

Table 1.

Distribution of patients by age and sex.

Age group	Gender				Total quantity	
	Men		Women			
	Abs. q-ty	%	Abs. q-ty	%	Abs. q-ty	%
from 31 to 40 y.o.	59	33.4	67	55	126	42
from 41 to 50 y.o.	50	28.3	21	17	71	23.6
from 51 to 60 y.o.	38	21.4	19	15	57	19
Above 60 y.o.	30	16.9	16	13	46	15.4
Total	177	100	123	100	300	100

All examined patients were divided into 4 groups: the first group included patients with generalized periodontitis and intact dental rows, the second group included patients with generalized periodontitis complicated by partial loss of teeth, the third group included patients with periodontitis and intact dental rows, and the fourth group included patients with periodontitis complicated by partial loss of teeth (Table 2). In addition, each group was divided into light (LD), medium (MD) and severe (SD) according to the severity of the process.

Table 2.

Distribution of patients by clinical forms and severity of periodontal disease

Clinical Diagnosis		Number of patients	
		Abs.	%
Chronic generalized periodontitis in intact dental rows	LD	15	5
	MD	17	5,7
	SD	7	2,3
Chronic generalized paradontitis, complicated by partial loss of teeth	LD	55	18,3
	MD	98	32,7
	SD	49	16,3
Paradontosis with intact rows of teeth	LD	4	1,3
	MD	5	1,7
	SD	2	0,7
Paradontosis complicated by partial loss of teeth	LD	21	7
	MD	19	6,3
	SD	8	2,7
TOTAL:		300	100

Patients were divided into two main groups when planning orthopaedic treatment. The first group (65 people) included patients who underwent traditional orthopaedic treatment with the use of splints and tires - prostheses, both removable and fixed. The second group (235 people) included patients who preferred to be implanted with traditional prosthetics. In the first stage of the examination, all patients were given appropriate comprehensive treatment, including occupational oral hygiene and periodontal disease treatment. Patients in the second group were screened again after one month to determine whether they were ready for dental implantation. A general blood test, blood sugar test, HIV, RW, Hbs-Ag tests were administered to all patients who were scheduled for a surgical intervention.

Each patient was given voluntary informed consent for surgical intervention with obligatory indication of proposed alternative methods of treatment.

To predict the implantation outcome, not only the data of preoperative diagnostics were important, but also, to a large extent, the examination results obtained at the second stage, when it is necessary to apply special methods of investigation.

Thus, at the second stage of examination anatomical topographic features of the planned implantation zone were determined and evaluated according to the generally accepted classifications Leholm-Zarb (1985), Misch (1993, 1999). Both the quantity and quality of bone tissue, the state of mucous membrane, as well as the state of blood circulation of the alveolar process and the alveolar part of the jaw were considered.

At the third stage of preoperative examination we faced the task of choosing the optimal prosthesis design, which, due to a large number of associated factors, cannot be planned without the use of mathematical modeling methods. While designing the prosthesis using the methods of mathematical modeling, we considered two systems: with support on implants and with fixation on natural tissues of the prosthetic bed (teeth, mucous membrane). The use of intraosseous implants provided preliminary modeling of the area of the supposed implantation using the data of clinical-roentgenological and morphological studies.

Laser Doppler flowmetry method was used to study the state of microcirculation channel of the mucous membrane of the supposed implantation zone. Measurements were carried out before surgical intervention, three to six months, and the 30th day after the prosthetic. LDF was carried out with the laser analyzer of capillary blood flow "LAKK-01".

The sensor of the device was placed in the area of the attached gingiva, providing its easy contact with the gingiva surface without squeezing the microcirculation channel. Indexes were registered within 2 minutes.

We used the panoramic tomography methods (zoonography of dental rows, orthopantomography), computer tomography of dental rows on the cone-beam dental computer tomography to make a diagnosis and determine the treatment tactics of patients.

Sterilization of prototypes of screw intraosseous dental implant made of titanium alloy VT-1 according to GOST 19807-91 with evaluation of quality and efficiency of sterilization was carried out in the Scientific Laboratory of Microbiology of TSDI.

At the preclinical stage the experimental samples of dental implants made of the titanium alloy VT-1 according to GOST 19807-91 were used.

Research results: to clarify the information about the state of bone tissue, we have carried out a special morphological study, which consists in the fact that it allows us to assess the structural

changes at the tissue and cellular level, that is, more fully assess the potency of tissue for synthesis and regeneration in the area of the proposed implantation.

Based on this, we offer a certain algorithm for microscopic examination of drugs, bone fragments with the selection of those characteristics that most fully reflect the processes of destruction and creation of bone tissue in their quantitative expression.

This, in turn, served as an argument for the attraction of the method of ball system estimation successfully applied in studies of a number of internal diseases (Zaiko N.N., et al. 2007; Cochroane C.G., Wiggins R.C. et al., 1984). However, in dentistry practice the ballast estimation of morphological details has not been applied yet, that has served as an incentive for development of this method in application to estimation of reparatively - synthetic features of local bone tissue zone.

During the research it was found out that the usual descriptions of biopsy cannot be implemented with statistical processing as analytical data. Hence the need for quantitative and semi-quantitative estimates of morphological changes.

Considering the degree of severity of other morphological changes: thickness of sponge substance beams, amount of osteoid, severity of glue line pattern, intensity of collagen fibers formation and development of vascular communications, degree of sclerosis of vascular walls, presence of rheological disorders we used semi-quantitative ballistic estimates of morphological changes. Numerical indices (diameter of gaver channels, quantitative counts of mesenchymal cells) were synthesized and also presented in scores.

The conducted histological research showed that structural features of the bone tissue in the patients with the implants placed are ambiguous. In this case two groups of patients corresponding to two types of measurements are quite clearly defined. Patients (37 persons, 55% of observations) of the first group dominate. They are characterized by the expansion of gaver channels, signs of thinning of bone beams, loose location of few "gluing lines", weak proliferation of cellular bone elements, poor synthesis of collagen fibers and osteoid deposition.

In general, representatives of this group are distinguished by the presence of bone tissue not only with signs of rarefaction, i.e. osteoporosis, but also by weakened potentials for bone formation in the presence of anemia of arteriol walls fibrosis and rheological disorders.

The second group of patients (22 persons, 32% of observations) was characterized by eburnation with narrowing of gaverse channels, thickening of bone beams of spongy layer, abundance of closely located "bonding lines", significant proliferation of bone cells and synthesis of collagen fibers. The least number of patients (the third group) were those with normal bone structure (8 observations, 12%).

When analyzing microcirculation using laser Doppler fluometry, we noted hemodynamic hemodynamics in patients with periodontal disease, which is consistent with the data of other authors (Mikhaleva, L.M., 2002; J. Pinchback, B. et al 1996). The obtained results of microcirculation indices in the area of missing teeth in patients with periodontal disease were characterized by some decrease of hemodynamics indices, which, in our opinion, is connected with both decrease of functional load and disappearance of part of capillary network in the investigated area due to tooth loss.

During the dynamic evaluation, carried out at different stages of prosthetics supported by implants, we noted the expressed tendency to increase the hemodynamic indices caused, first of all, by the change of conditions of the dental system functioning. Change of chewing pressure force in the area of missing teeth caused the necessity to adapt to the appeared chewing load on the implant, which, in its turn, stimulated the blood network development and improvement of the surrounding bone tissue

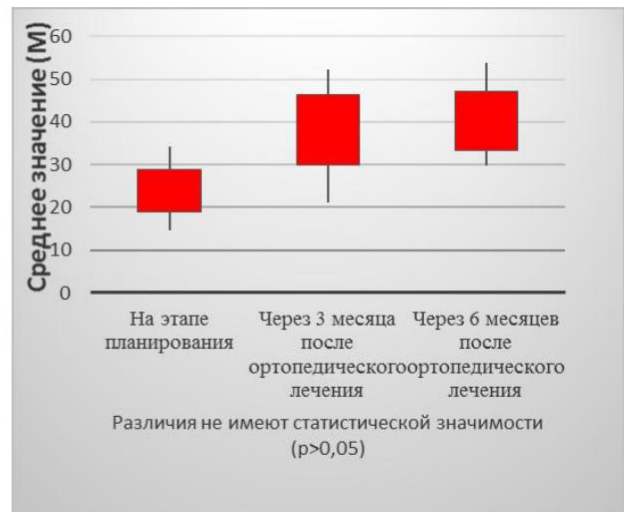
trophicity. The dependence of the hemodynamics parameters change obtained by us at the change of the conditions of the dental system functioning does not contradict the data available in the literature (N.K. Loginova, E.K. Krechina, 1998; Kastberger G., 2003) (Table 3).

Table 3

Microcirculation indices in patients with periodontal disease

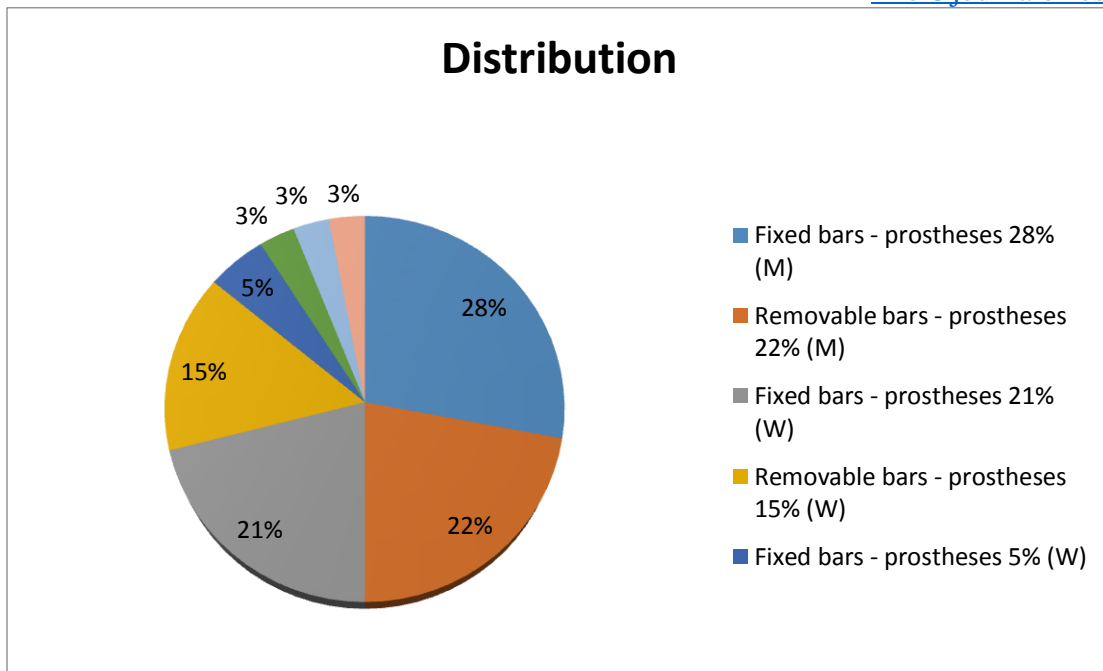
Microcirculation rate	Patient group			
	Control group	Patients with periodontal disease		
		In the planning stage of orthopedic treatment.	3 months after orthopaedic treatment.	6 months after orthopaedic treatment.
Average arithmetic value of microcirculation indicator M	27,13±6,7	23,83±5,0	38,18±8,2	40,26±7,0

Показатели микроциркуляции	Группы пациентов			
	Контрольная группа	Пациенты с заболеваниями пародонта		
		На этапе планирования ортопедического лечения	Через 3 месяца после ортопедического лечения	Через 6 месяцев после ортопедического лечения
Среднее арифметическое значение показателя микроциркуляции M	27,13±6,7	23,83±5,0	38,18±8,2	40,26±7,0



Thus, the study of the functional state of the vessels in the area of implantation makes it possible to judge about the availability of reserve capabilities of the vascular channel, which allows forecasting the course of the postoperative period, the success of osseointegration of the implant and the validity of the used structure.

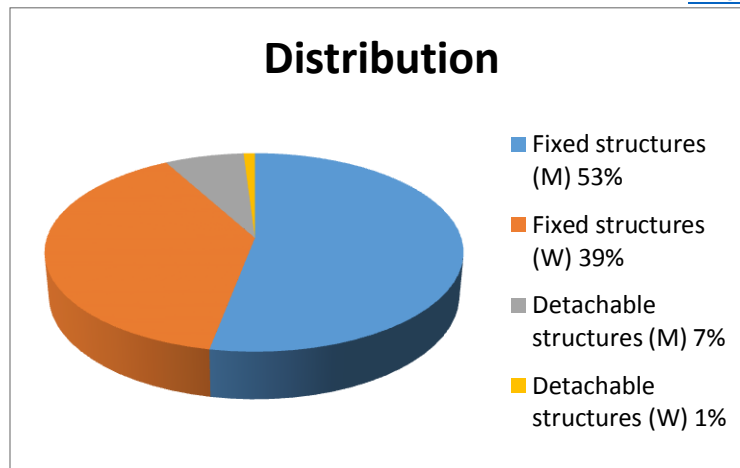
Clinic. There were 300 patients with periodontal disease under our supervision, which were divided into two main groups. The first group (65 people) included patients who underwent traditional orthopedic treatment with the use of tires and splints - prostheses, both removable and fixed, and their combination (Fig. 1).



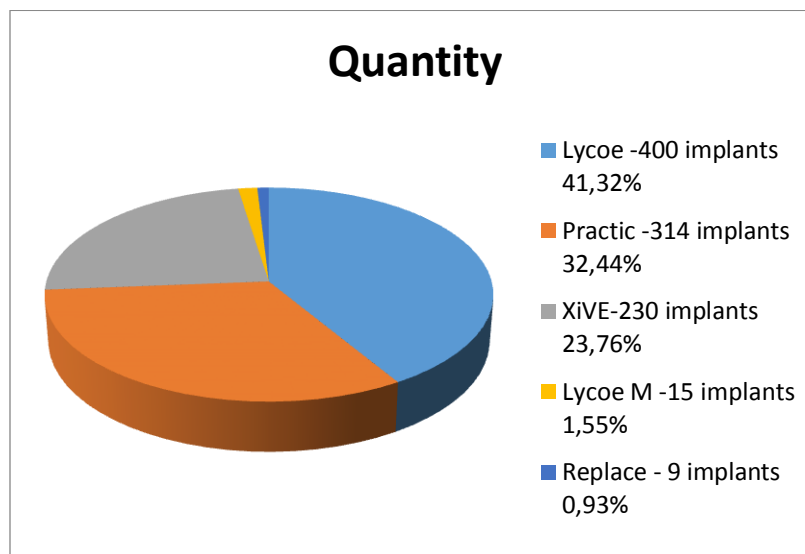
Pic. 1 - Distribution of patients in the first group by gender and type of orthopedic structures.

The development of new systems of removable dentures fixation in case of partial loss of teeth should be aimed at improving the quality of prosthetic replacement of defects in the dental row and creating a single standard of treatment based on the design features of the prosthesis that meets the requirements of functionality (increase in prosthesis stability), universality (use under different clinical conditions), reducing the functional overload of periodontium, as well as aesthetics and economic efficiency.

Based on our own observations, we concluded that the use of tires and prostheses in the orthopedic treatment of generalized periodontal disease contributes to a certain stabilization of the pathological process, but in no way will not buy it. This is due to the fact that tires and prostheses have a traumatic effect on the periodontium of the remaining teeth and do not contribute to the stabilization of the process. Progressive atrophy, especially in the area of the remaining teeth, eventually leads to the development of extreme pathological mobility and their loss. Thus, there is an urgent problem of eliminating and reducing traumatic occlusion, which in our opinion can be achieved by using implant systems. Further search for ways to improve the methods of implantation with the use of the most optimal orthopedic design will contribute to more effective rehabilitation of patients with periodontal disease. To solve these tasks, we accepted for treatment with implants 235 patients (the second group) who preferred implantation to the traditional types of prosthetics (Pic. 2), to whom 968 implants were placed (the second group, pic. 3).



Pic. 2 - Distribution of patients in the second group by gender and type of orthopedic structures.

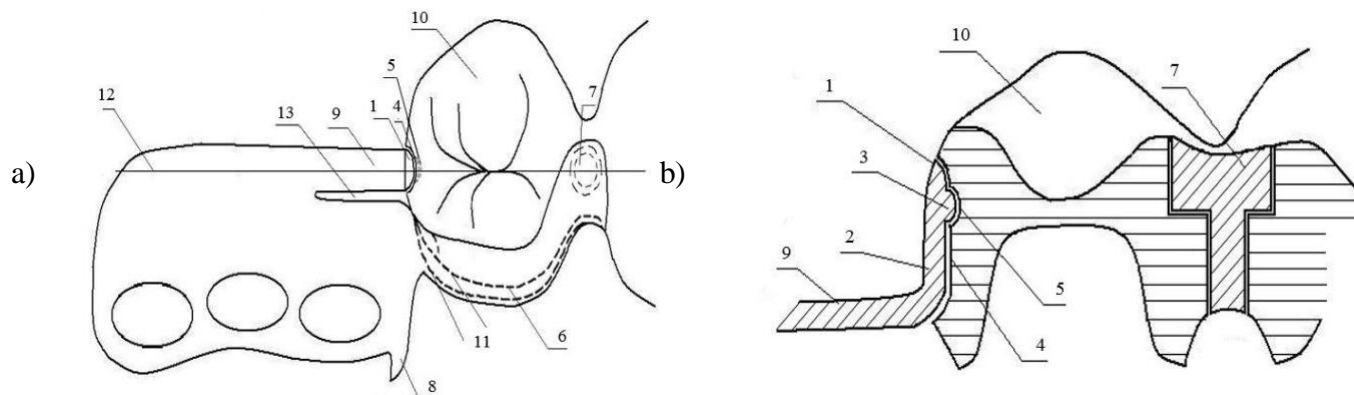


Pic. 3 - Number and types of implants placed in patients with periodontal disease.

The use of intraosseous implants provided preliminary modeling of the area of the supposed implantation using the data of clinical-roentgenological and morphological studies.

Special attention in our work was paid to the peculiarities of orthopedic treatment in patients with contraindications for implantation.

Bearing these features in mind, we have developed and proposed the design of a new locking device that provides physiological distribution of load along the longitudinal axis of the supporting tooth, as well as sufficient fixation and spatial stabilization of the prosthesis, but at the same time only partially limiting the lability of the prosthesis during function (Pic. 4).



Pic. 4 - Lock pattern of the removable denture a) view from above b) view from the oral side.

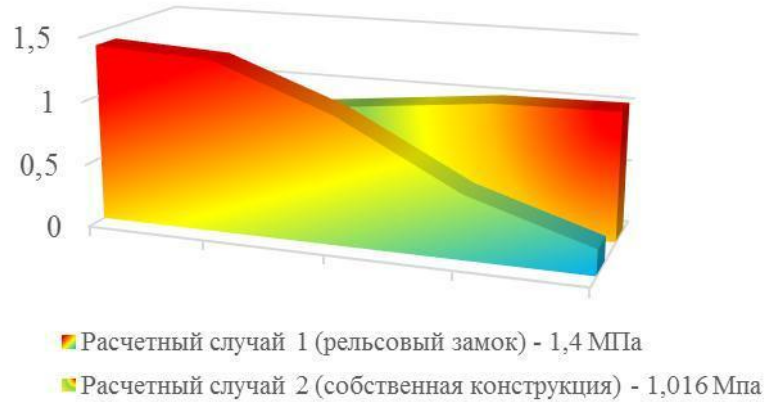
The patented part of the anchorage 1, consisting of shoulder 2 and hemisphere 3, is part of the prosthetic base 9. The base is slotted 13. Matrix part 4, which includes a hemispherical recess 5, is part of the artificial crown 10. Numbers are marked: 6 - shoulder displacement distribution, 7 - interlock, 8 - base stop, 11 - support crown milling 12 - cross-sectional plane.

Limited liability of the lock fixation determines the reduction of the load on the periodontium of the supporting teeth due to the redistribution of part of the chewing pressure on the mucous membrane of the alveolar process or the alveolar part, which agrees with the opinion of Abolmasov et al., (2001) and Lebedenko et al., (2004), which recommend excluding the occlusal thrust by "crushing" the chewing load and transferring part of it to the mucous membrane of the denture bed.

The proposed anchorage is intracortical, the advantage of which is the distribution of chewing pressure along the longitudinal axis of the supporting tooth, which is physiological in contrast to other structures and allows to significantly reduce the risk of movement and inclination of the supporting teeth. In addition, this design is much more hygienic than the extra crown and has no traumatic effect on the interdental gingival papillae.

To confirm the effectiveness of the proposed design, we carried out a comparative biomechanical analysis of the most commonly used lock fixings using the finite element method.

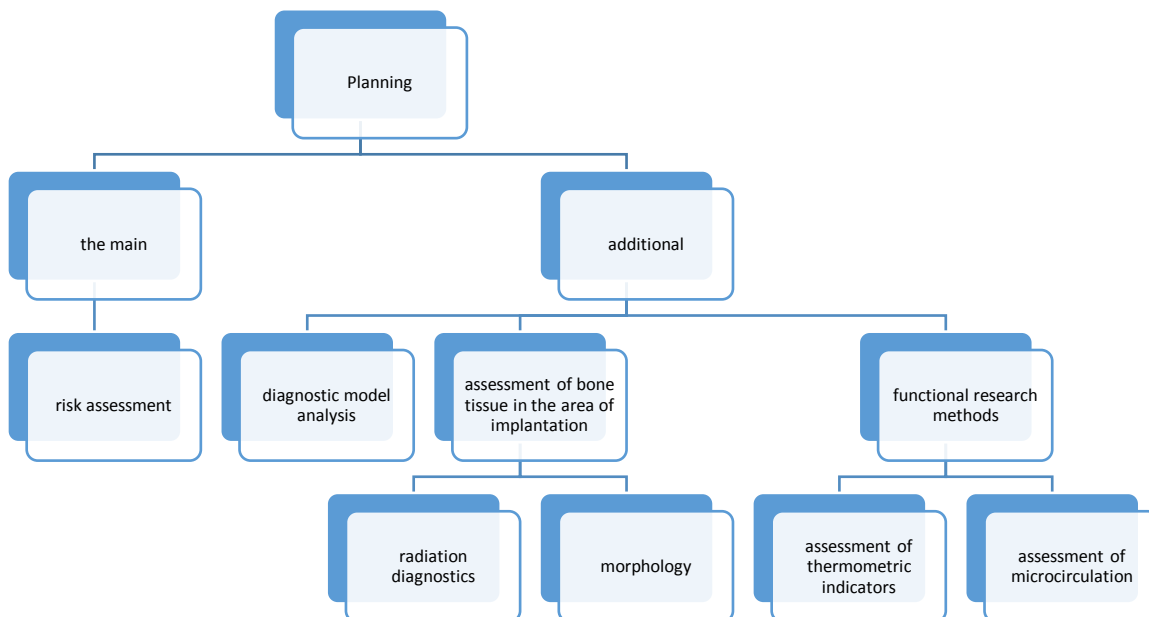
Created models with tetrahedral finite element mesh and a given load of 950000 N/m² which corresponds to 100 N (10 kg) per tooth, as the surface area of one tooth is 106 mm². were analyzed by Solid Works Simulation. According to the obtained epitures of equivalent Mizes stresses, the maximum stresses in the periodontium in the first case were 1.4. Mpa. and in the second case 1.016 Mpa. We have shown the obtained results of calculation in the diagram (Pic. 5).



Pic. 5 - Results of maximal values of stresses of lock fasteners.

Thus, the comparative biomechanical analysis has shown that using the locked joint we propose decreases the load on periodontal tissues in relation to rail connections by 27%. All this increases the service life of the prosthesis not only in statics, but also under cyclic loads, which has a positive effect on the supporting teeth.

Generalization of the results of using the algorithms of preliminary and additional (final) examination methods allowed us to create an algorithm of general approaches to planning and prosthetic treatment of patients with partial loss of teeth (Pic. 6).



Pic 6. - Orthopedic Treatment Planning Algorithm.

One of the stages of work was the correlation analysis between the main clinical, instrumental and morphological characteristics obtained in patients with periodontal disease of different severity.

In our research, special attention was paid to the relationship between the data obtained from microcirculatory, thermographic and morphological analyses, as well as the results of the oral cavity

index assessment using the periodontal Russell Index, Quiqley-Hein Hygiene Index and the Muhlemann-Cowell Blood Index. Furthermore, it was of greatest interest to identify the relationship between clinical, instrumental and morphological indicators and the results obtained by applying the PPR system we developed to prove its practical effectiveness.

It has been suggested that the nature of correlated links between basic clinical, instrumental and morphological characteristics may be of prognostic importance in the issue of orthopaedic treatment in patients using an expert decision support system.

In the course of correlation analysis between clinical, instrumental and morphological characteristics in 25 patients the following positive correlation links were revealed: between Mullerman's indexes and Expert System ($p=0,00001$), IG and Expert System ($p=0,0001$), IG and Mullerman's index ($p=0,00001$),

Thus, according to the correlation analysis data, it is possible to evaluate the clinical picture at the stage of orthopaedic treatment planning in the most complete way using index assessment indices - Quiqley-Hein hygiene index, Muhlemann-Cowell blood flow index and Russell periodontal index. The information obtained as a result of these methods of research provides an opportunity to assess the patient's body condition in the most complete way, which helps to reduce the number of errors during the planning stage of orthopaedic treatment. At the same time, we offer the most complete algorithm of orthopedic treatment taking into account the most important planning stage to generalize all algorithms and developed expert system.

CONCLUSIONS:

1. The application of the new design of the detachable tire-prosthesis locking for the treatment of patients with periodontal disease complicated by partial loss of teeth reduces the load on the periodontium of the supporting teeth in relation to the rail joints by 27%, which has a favorable effect on the supporting teeth and the surrounding tissue of the prosthetic bed. Application of the method of milling the supporting crowns and the presence of inter crown interlocking (stabilizer) in combination with distally located lock fixation provides fixation and stabilization of the prosthesis in all planes.

2. The developed algorithms of methods for planning of orthopedic treatment of patients with partial loss of teeth, as well as the algorithm of general approaches to prosthetics in periodontal diseases, created on their basis, allowed to consider them as an expert system of support of clinical decision-making in planning of orthopedic treatment and to use it for registration of possible changes in the process of dynamic observation of patients and, if necessary, to carry out conservative measures in time, as well as to predict the outcome of the prosthesis.

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