QUANTIFICATION OF PREDICTABLE CLINICAL-BIOLOGICAL INDICES FOR A CORRECT PROIMPLANTATION DIAGNOSIS

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ABSTRACT

Aim of the study The success of the implant therapy is co-dependent on the correct pre-implant assessment of the general, loco-regional and local status, the surgical and post-surgical stage or prosthetics as well as maintenance. In order to appreciate and evaluate the candidate for implanted therapy, a series of markers or clinical-biological indices are followed. The present paper proposes an updated synthesis of the opinions from the specialized literature regarding them, with the aim of preparing an update regarding the scientific results of recent years.

Material and methods Systematic reviews, meta-analyses on the influence of general and local factors on the success of implant therapy, clinical-biological indices, success rate, peri-implantation, using electronic platforms available until June 26, 2023, were included for analysis.

Results Clinical-biological indicators of general condition influence the patient's response both in the immediate post-therapeutic healing stage and long-term implant retention. At the same time, the patient's general condition conditions the time and extent of the surgical intervention.

Conclusions A number of general conditions are mentioned in the literature that contraindicate the surgical intervention in ambulatory conditions, such as myocardial infarction more recent than 6-12 months, acute leukemia, stroke more recent than 12 months.

Key words: clinical-biological indices, implant therapy, implant imaging.

INTRODUCTION

The main driving processes that shape or rather reshape contemporary society are globalization and the associated technological progress, trends that dental medicine follows, of course, just like the other medical specialties. These elements, as indicated by the WHO, attract a phenomenon of population aging, characterized by a series of effects and implicitly, predictions including the increase in the need to apply implanto-prosthetic strategies. This need has been detected in the last decades, through various cohort studies, which emphasize the increase in the prevalence of patients over 70 years old in dental offices.

There are also positive effects in tune

with technological progress and the development of living and working conditions, such as an increase in the prevalence of outstanding dental units on the arch and respectively a decrease in the prevalence of total edentulousness or of patients who apply for completely removable therapy. However, the phenomenon of physiological aging also affects the prosthetic field through the resorption of alveolar ridges, the reduction of keratinization, the decrease of the pain-pressure threshold, hyposalivation, which increases the level of difficulty in solving cases through conventional therapies and can favor implanto-prosthetic therapy.

Given these data, and in an attempt to find the recipe for success, a forced term in this case, we proposed to start with what we already know, failure being easier to recognize than success.

Materials and methods

This review was carried out in accordance with the PRISMA rules using the modified PICO model. So that systematic reviews, meta-analyses on the influence of general and local factors on the success of implant therapy, clinical-biological indices, success rate, peri-implantation, using electronic platforms available until June 26, 2023, were included for analysis. The included articles were published in English, and the databases accessed were MEDLINE/PubMed, Scopus, Cochrane and Prospero.

The selection criteria followed the publication date for which articles published in the last 10 years were included, and the inclusion criteria were:systematic reviews regarding studies on subjects where the medication and implant success rate were analyzed, systematic reviews and meta-analyses, articles published in English, articles published in the last 10 years. Exclusion criteria: non-systematic review, articles published in a language other than English, in vitro studies or animal review. The abstract of the articles was read by two subjects independently and the most relevant ones were selected, the cited bibliography includes only the relevant articles for this review.

Results and discussions

The general clinical-biological indicators aim at the patient's age favoring the tissue healing process, the repair processes taking place physiologically without atypia, the lack of associated conditions, and the patient's gender both through physiological factors and through the patient's expectations. If in the case of female patients, a series of hormonal variations produced by physiological states influence the healing and bone remodeling process when we talk about aesthetic expectations and preferences, male patients are considered to be less demanding.

If we refer to the general status of tissue conditioning, then cardiovascular diseases are taken into account. A study by Gulbahar et cola, in 2020 regarding the relationship between markers of cardiovascular disease and peri-implantitis, in which periodontal indices such as probing depth, probing bleeding, plaque index and biochemical parameters such as LDL, cholesterol were analyzed.[1]

Regarding metabolic and immune disorders, a number of factors are taken into account, such as the microbiota of the

digestive tract and the ability of the body to defend itself, oxidative stress and the inflammatory response. So most studies focus on the correlation of plaque index and oxidative stress and inflammatory response respectively.

Metabolic disorders and the success rate have a maximum value of 82.9%, where 5-8% are associated with the bacterial plaque index.[2] The relationship between oral conditions and systemic metabolic disorders is bidirectional, having a determining character, so that appropriate management of underlying metabolic disorders could determine practice outcomes.

Oxidative stress damages cellular macromolecules such as nucleic acids, proteins, and lipids. Periodontal disease is a direct result of oxidative stress through reduced body defense capacity and tissue damage.[3]

The inflammatory process in the perception of Landgraeber et al. predicts implant failure by mediating cytokines determined by the innate immune system. Also, the inflammatory process that accompanies conditions such as chronic periodontal disease affects the metabolic process. [4]

Among the multitude of metabolic factors and conditions, smoking and diabetes were incriminated by Kormas et al., but we will also mention other conditions in the following.[5]

Regarding obesity as a condition, as a result of metabolic disorders, with an increasing incidence in recent years, it attracts by its features a phenomenon called low-grade chronic inflammation.[6] Vohra et al measured the level of C-reactive protein and pro-inflammatory cytokine C and marginal bone loss, reporting significantly severe forms in obese patients.[7] Also, salivary concentrations of inflammatory cytokines IL-6 and IL-1β were measured showing that obese patients are more prone to develop inflammation compared to non-obese subjects.[8] Diabetes mellitus induces a disorder of glucose metabolism through hyperglycemia, associated with multiple micro and macrovascular complications, affecting the body's homeostasis, complications such as delayed wound healing, reduced ability to fight infections, tooth loss and periodontal disease are highlighted. Also the level of glycated hemoglobin was directly correlated with inflammation in these subjects.[9]

The evaluation of diagnostic markers to predict the failure of implant therapy was studied by Jacobi et al. on a group of 109 subjects, being studied Markers IL1A -889 C/T (rs1800587), IL1B +3954 C/T (rs1143634), IL1RN + 2018 T/C (rs419598) and TNFA -308 G/A (rs1800629) genotyping, in vitro IL-1β/TNF-α and by lymphocyte transformation assays. A greater stimulation of TNF-α and IL-1β was identified in patients with peri-implantitis. Minor polymorphisms were also studied, also highlighting a higher prevalence in cases of implant rejection. The increasing number of polymorphisms and risk genotypes associated with implant loss suggests their additive nature and can be considered as prognostic markers in the assessment of individual risk.[10]

Regarding other genetic conditions such as ectodermal dysplasia, a hereditary condition in which hypodontia is the second sign frequently associated with the lack of development of alveolar ridges and

decreased bone volume inadequate to support a conventional prosthesis, it can be stated according to Kaplan-Meier that the survival rate is 76% for the anterior jaw area, which allows the use of endosseous implants in this category of patients with adequate jaw precautions. [11]

In these conditions, it is imperative to analyze the general status through interdisciplinary collaboration with the specialist doctor in order to balance and prepare the candidate for pro-implantation therapy in order to identify genetic anomalies such as ectodermal dysplasias associated with hypo or anodontia, neurological conditions, endocrine conditions, associated and included pathologies in the oncological sphere, skeletal conditions and related to bone development, hourly conditions, mental conditions, etc.

In patients without co-morbidities, the standard screening evaluation of the general status through a biochemical and hematology report is applied. The purpose of laboratory investigations is to reduce the inaccuracy of the clinical and anamnestic examination, and their importance varies according to the characteristics and the clinical situation.

Local-regional clinical-biological indices

We consider positive loco-regional clinical-biological indices when there are no clinical and radiological signs to indicate joint suffering, the condylar excursions are symmetrical and synergistic, without lateral deviations of the chin, lack of joint noises.

Regarding the mandibular-cranial dynamics and relationship, the mandibular-cranial malrelations through rotation, translation or tilting need to be corrected from the pre-implantation stage, the treatment being timed and the patient's provisional prosthesis through other therapeutic solutions being necessary.

From a loco-regional point of view, an assessment is made of the static and dynamic cranio-mandibular complex architecture, as well as the anatomical and morphological integrity of the components of the cranio-cervical system.

In terms of local-regional homeostasis without and perhaps pathology of the temporomandibular joint, cervical spine conditions and muscle pathology directly affect mandibular dynamics and occlusal balance, where special attention is paid to the study of implant therapy in patients with oncological pathology in the region of the cephalic extremity because this disease, often with an oral localization, has devastating and even mutilating effects.

Eik Schiegnitz et al performed a meta-analysis of the survival rate of oral implants in a cohort of subjects who underwent radiation treatments to the cephalic extremity. The results of the study carried out by this group of researchers show an average success rate of 87.8% (34%-100%), the higher failure rate being predominant in patients with radiotherapy, this study also shows that failure had a prevalence higher in implants inserted post-irradiation than in patients with oral implants who underwent radiotherapy. In this study, it was also reported that bone augmentation increases the prevalence of adverse reactions in combination with radiotherapy. [12]

Local clinical-biological indices

If at the suprasystemic level the identification of factors favoring or disturbing the homeostasis of the stomatognathic system is sought, at the

local level of evaluation of the stomatognathic system, the analysis of the component elements as well as the synergy of the components of the complex is carried out.

The local paraclinical evaluation can include oral microbiology tests, such as the Snyder test, Dentocult and can be completed by the vitamin c test, cytological and stomatoscopic examinations, anatomic-pathological examination, intravital staining.

Regarding the oral microbiota, the microbial profile of peri-implantitis has elements in common with that of periodontal disease, the bacterial species common both in periodontal disease and this being: Aggregatebacter actinomycetemcomitans, Prevotella intermedia, Porphyromonas spp.[13],[14],[15],[16],[17],[18],[19],[20]

The evaluation of the local clinical-biological indices is carried out clinically and paraclinically through the study model, the imaging balance, the computerized analysis, the volumetric morphology of the region in order to identify the structure of the cancellous and compact bone that make up the supporting bone cortex, the density of the periodontal components, the relationship with the neighboring teeth and the opposing teeth, the condition of critical structures in the vicinity.

The evaluation of the alveolar bone contains a qualitative and quantitative component. Qualitative analysis includes bone density evaluation, cortical and spongy evaluation. Quantitatively, parameters are followed horizontally in the vestibular-oral sense and the dimensions in the vertical sense of the height of the available bone to which the thickness of the bone cortices is added.[21]

Imaging plays an important part in the dental implant procedures. The imaging vary from standard projections routinely available in the dental office to more complex radiographic techniques typically available only in radiology centers. Implant imaging provides accurate and reliable diagnostic information of the patient's anatomy at the proposed implant site.

Intra-oral: periapical radiographs

These are currently used in the dental office. They provide periapical views of the best resolution to diagnose periapical and periodontal pathologies. (Fig. 1) These films provide fine details of trabecular condition, angulation of adjacent teeth, and periodontal condition of adjacent teeth. The disadvantage is that these films give us the two-dimensional image of a three-dimensional object. These films, having a limited size, are insufficient for the evaluation of extended edentulous areas. It does not determine bone density and mineralization density. Magnifying the image which can be a false reading result

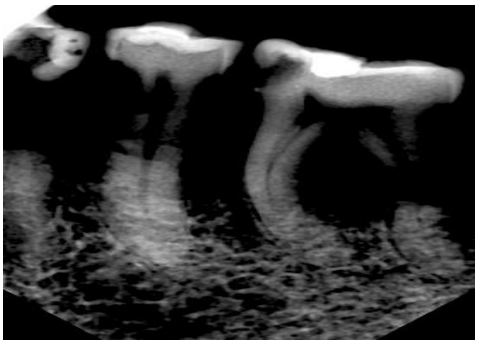

Figure 1: high degree of bone resorption

Occlusal radiography

This is indicated in clinical situations by the presence of trismus or ankylosis of the temporomandibular joint, these conditions do not allow the patient's mouth to open. They can also investigate the

spatial orientations of some roots or the position of the included teeth, and in the case of a fracture, identify the degree of movement in the vestibulo-oral direction of the fracture fragments.

Occlusal radiographs provide little information regarding treatment planning in implantology. Provides a cross-sectional view, used to calculate dimensions he bone. They cannot accurately provide the bone dimensions at the crestal level that help to identify the implant diameter. (Fig. 2)

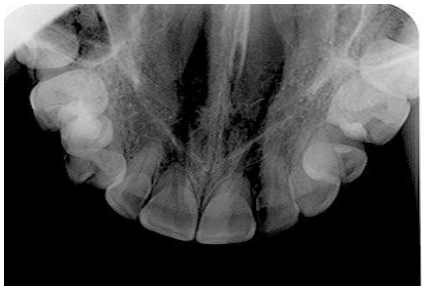

Figure 2: occlusal radiography

Cephalometric lateral radiographs

These are useful in planning the position of the implant and the orientation of both the maxilla and the mandible. It renders accurate information about the available bone in the sagittal region of both the maxilla and the mandible. The long focal length of film causes minimal magnification. In cases of partial edentacy, it provides information about the position and angulation of the roots of the teeth as well as important landmarks, such as: the mandibular canal and the maxillary sinus. [22],[23],[24],[25]

Panoramic radiography

It is an important component of radiology for dental diagnosis. This provides information about the bone anatomical contouring and is generally used to diagnose pathologies, as well as in the relationship between anatomical structures.

The X-ray source rotates behind the patient's head, which emits radiation that is limited to a narrow vertical beam by a lead collimator at the front of the tube head. At the same time, the film cassette holder passes in front of the patient's head, the film moves in the opposite direction of the X-ray beam behind a lead shield, which allows only a small part of the film to be exposed through a narrow slit. The point around which the X-ray source rotates is called the center of rotation.

The rate at which the film moves is correlated with the rate of movement of the X-ray beam which identifies the patient's tissues, equalizing the vertical and horizontal magnification of certain structures in the image and thus minimizing distortion.

There are several advantages of panoramic radiography which include:wide visualization of the anatomical region, including additional visualization of areas of the mandibular body beyond the periapical region, ramus, temporomandibular joint, and maxillary sinus, which are especially important during treatment planning of a patient for an implant. In general, the radiation dose is relatively low, it provides a radiation dose equivalent to approximately a set of four bitewing intraoral films. Reduction of time and greater ease for the production of a single image representing the entire dentition of the patient. Limitations of orthopantomography include: major limitation of traditional panoramic radiography is the inability to generate cross-sectional images of the alveolar ridge. These images are important in determining the height, width and angulation of the alveolar ridge, as well as

the distance between the alveolar ridge and the mandibular canal, the floor of the maxillary sinus, or the nasal cavity. Not identifying the quality and degree of mineralization of the bone. Fine anatomical details as seen on intraoral periapical radiographs are unavailable. Geometric distortions and superimposed images of the teeth.

Panoramic projection measurements are generally insufficiently precise for a dental implant insertion. (Fig 3,4) 22,23,24,25

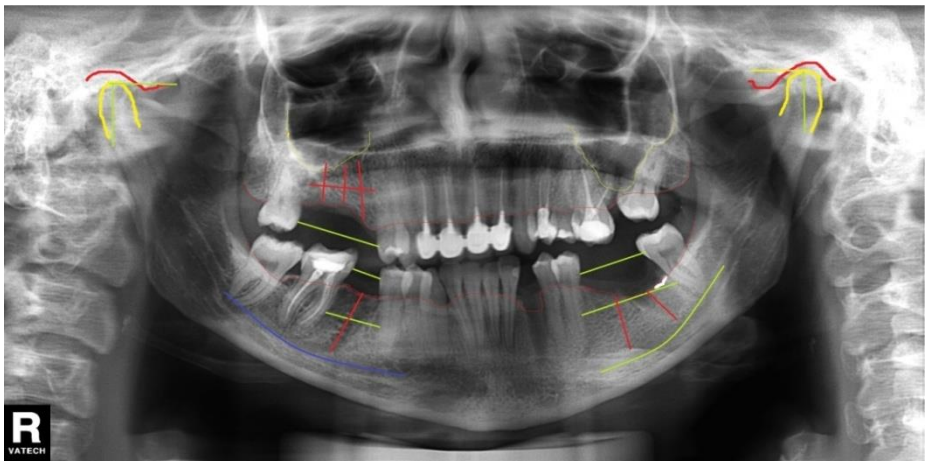

Fig.3: Orthopantomography -2D Analysis of the bone support with identifications:
• At the level of the temporomandibular joint: rotation condyles
• Horizontal alveolar resorption with generalized character 2-4 mm, affecting the interdental septum
• The presence of post-extraction radiolucent areas

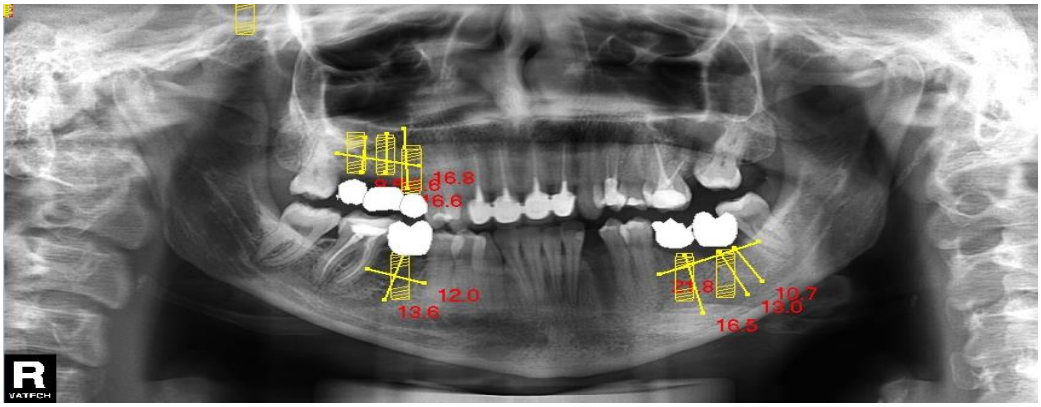

Fig.4: Orthopantomography-2D Analysis of the pre-implant space in all four quadrants

Computed tomography

This radiological process involves the generation of narrow sections through an object. It is a non-invasive technique that allows visualization of internal structures. The simplest form of tomography is linear tomography in which the X-ray tube contains a series of films in a straight line. The movements are complex and are of several categories, namely: circular, cylindrical and octospiral which create a clearer image. The quality of the image produced depends on the type of movement, the thickness of the section and the degree of magnification. Conventional tomography can be used to plan a single implant in a certain area.

It is very useful in determining the dimensions of the implant, because it provides precision in the spatial

relationship of important structures, such as the inferior alveolar canal, maxillary sinus and other anatomical areas. The digital conversion of the image allows the use of tools such as a ruler to determine the dimensions of the area under investigation. Tomography being complex with a high level of quality, it provides quantitative and geometric information of the bone available for the placement of the planned implant.

Computed tomography can be divided into two categories based on the acquisition of X-rays by beam geometry, namely: fan beam and cone beam.

In the fan phase scan, it is performed with the help of a narrow beam of X-rays in the shape of a fan transmitted through the patient. The tomographic image is divided into two stages. In the first stage, the physical measurement of the attenuation of the X-rays that cross the patient in different directions takes place, and in the second stage, the mathematical calculation of the linear coefficients is processed. The beam is captured on an amorphous silicon flat panel or image intensification detector (CCD).

The beam diameter varies from 4 to 30 cm and exposes the head in a single pass around the patient, capturing 160 to 599 basic images. In this way, 3-D images of bone or soft tissue surfaces can be generated. (Fig. 5) [27],[28],[29],[30]

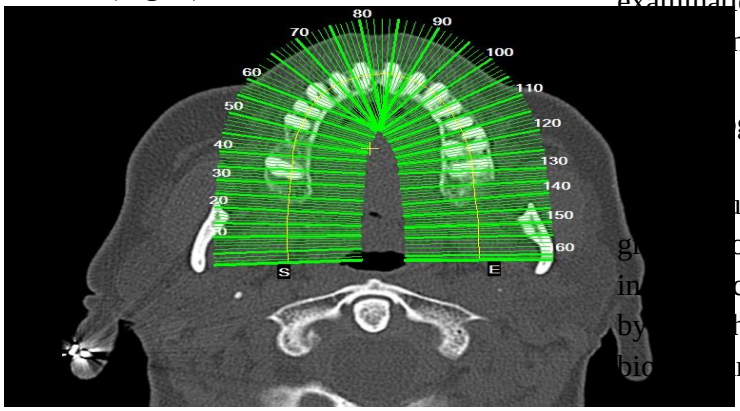

Fig.5: CT-SCAN with the presence of image sections

Volumetric tomography with a cone beam

Cone-beam volumetric tomography refers to a tomographic imaging beam that is focused to a narrow area of the body. Multi-dimensional images of the hard tissue of the jaw can be obtained using this technology. (Fig.6)

The cone beam renders an image of the hard tissue that has no distortion and is anatomical. Axial, transverse, coronal, sagittal, panoramic views can be obtained with the help of CBCT. [31],[32],[33]

Fig.6: Cone beam computed tomography in different sections

Predictable clinical-biological indices for a pro-implantation diagnosis

Periodontal indices

Dento-periodontal support presents specific clinical-biological indicators quantified in relation to the clinical examination following the number of teeth n the arch, topography, distribution arch, coronal and radicular gy, implantation, dento-arodontal

umber of teeth on the arch is hereby gi or not a long political or negative in consideration and the values given by he and Duchange for indices of bio nical competence. Also, the

biomechanical value according to Ante and Watt specifying the ratio between implantation and root surface should be taken into account. Any change in coronary integrity includes negative values bringing disturbances in the local homeostatic balance. By changing the seat, the number and the position of the remaining teeth on the arch in the framework of dental disharmony, the level of difficulty of the case is always higher.

Periodontal indices alone do not define implant success or failure. These clinical indices are related to other factors such as the presence or absence of periodontal space exudates. Even so, understanding the basic criteria and the evaluation indices allow establishing some differences between health-disease, implant quality in relation to implant therapy. [34],[35]

As a whole, dento-periodontal indicators are positive when: the absence of teeth on the arch is reduced, the distribution of the present teeth is favorably grouped (the space potential prosthesis is delimited mesially and distally from the teeth), implantation is normal, the morphology is intact, the anatomical retentivities are normal, the coronary index is favorable, wear is within physiological limits (attrition), the periodontal support is healthy.

Dento-periodontal indices are negative when: the number of teeth present is reduced, the potential prosthetic spaces are limited only distal to the teeth, the contact points are absent, implantation is deficient (malpositions over 35 degrees), coronary morphology is affected by caries, abrasion, dystrophies, the coronary index is reduced, the periodontium is affected with signs of inflammation, recession,mobility, gingival retraction and bone resorption.

Anatomical factors

Most dental implants do not invade anatomical risk areas such as the infraorbital or mandibular canal, and to evaluate implant success we must assume that the implant has not damaged main nerve trunks. [36], [37], [38]. Subjective factors can be associated in the healing stage, the absence of pain when exerting vertical and horizontal forces could be a subjective primary criterion.

PERIIMPLANT CORTICAL RESORPTION

Peri-implant marginal bone is generally a significant indicator for assessing success. The level of the crestal bone in relation to the position of the implant measured immediately after the implant. The most popular method (described in the literature) is the post-implantation radiological evaluation after the healing period. Of course, conventional radiographs transpose a three-dimensional image into a two-dimensional image, which distorts the result.

THE PRESENCE OF infraosseous pockets

The periodontal survey for natural teeth has proven to be an excellent examination to indicate the state of periodontal health, but the peri-implant survey may mean too little for diagnosis if it is not complemented by other paraclinical examinations.

The benefit of this investigation consists in an index that can highlight the loss of bone level over time but does not indicate osseointegration or the disease state. Implants with favorable stability may have pockets between 2 and 6 mm. Lekholm et al detected the presence of peri-implant bags that are not closely related to an aggressive resorption phenomenon.

Dental implants usually have false pockets because the periodontium and implant never bond as they do between bone and periodontium due to the circular fibers that act as a shrink sleeve around the implant maintaining the level of gingival attachment.

The periodontal alveolar bone resorption index is established on radiographs and can

have the following values: 1-normal alveolar bone, intact alveolar limbus in relation to the level of the anatomical package, or at most 1 mm below it, 2-alveolar resorption affecting 1/3 of the total length of the root, 3-alveolar resorption affecting 2/3 of the total length of the root, 4-alveolar resorption affecting more than 2/3 of the total length of the root.

At the level of the muco-bone support, indications for the oral mucosa and the maxillary bone or mandible are targeted by assessing the resilience of the mucosa and the health status of the oral mucosa.

The muco-osseous substrate shows positive indicators when:dentate ridges are favorable (high, rounded, horizontal) with low degree of bone resorption, favorable Rubens-Duval indices, vault medium or flat palate, absence of the torus, biostatic areas favorable, favorable mucosal indices, the lingual slope of the ridge favorable, tongue in intermediate position with normal appearance and volume.

Negative clinical-biological indices of the muco-osseous support are represented by:sharp, low, resorbed, ascending or descending edentulous ridges, the vestibular and oral slopes have an unfavorable inclination, they are retentive, the palatal vault is ogival or deep with the presence of the torus, the biostatic areas are atrophied, horizontal mobility indices are present, Rubens-Duval indices have increased values, the floor is herniated, the tongue and the palatine wave have an unfavorable position. Atrophy of the maxillary and mandibular bones follows the same classification according to Misch and Judy, being of reference, although other authors such as Schroder or Koller-Russov can also be taken into account.

Biomechanical considerations

Prosthetic rehabilitation aims to restore the correct biomechanical distribution both at the occlusal and at the bone level, becoming a predictable criteria for implant success.

The static and dynamic occlusion relationship in the candidate patient for implanted therapy will aim to achieve a balance that allows balance in the centric relationship and the maximum intercuspidation relationship with free way space and less of the centric point type that requires the concentration of forces and last but not least the position of physiological rest or the relationship of posture in therapeutic conditions supported by the rest of the remaining natural odontal elements, the gingiva and the alveolar ridges. [39],[40],[41],[42]

RESULTS AND DISCUSSIONS

The relationship between oral conditions and systemic metabolic disorders is bidirectional, having a determining character, so that appropriate management of underlying metabolic disorders could determine practice outcomes. In these conditions, it is imperative to analyze the general status through interdisciplinary collaboration with the specialist doctor in order to balance and prepare the candidate for pro-implantation therapy in order to identify genetic anomalies such as ectodermal dysplasias associated with hypo or anodontia, neurological conditions, endocrine conditions, associated and included pathologies in the oncological sphere, skeletal conditions and related to bone development, hourly conditions, mental conditions, etc.

CONCLUSIONS

Clinical-biological indicators of general condition influence the patient's response both in the immediate post-therapeutic healing stage and long-term implant retention. At the same time, the patient's general condition conditions the time and extent of the surgical intervention. A number of general conditions are

mentioned in the literature that contraindicate the surgical intervention in ambulatory conditions, such as myocardial infarction more recent than 6-12 months, acute leukemia, stroke more recent than 12 months. These contraindications apply to all surgical interventions.

Effective implant placement requires an appropriate planning. This can be accomplished by using a number of imaging methods. The most accessible to patients are the two-dimensional modalities. As a result, one of the first recommended method is panoramic radiography. Beside the low cost of the panoramic radiography, CBCT is the preferred method for implant imaging due to its superior benefits over the other techniques.

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