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IMPLICATIONS OF BIOMATERIALS AND MODERN TECHNOLOGIES IN FIXED PROSTHETIC REHABILITATION OF PATIENTS WITH DIFFERENT SYSTEMIC DISEASES

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Abstract: The therapeutic solutions chosen were ceramics on a zirconium support or ceramics on a metal infrastructure made by laser technique, which is a therapeutic alternative beneficial for the relationship with the affected tissues, a situation that is found in patients with cardiovascular or other types of general diseases. In addition to the technological line chosen, the biomaterials chosen are also extremely important, with Co-Cr alloys remaining a biocompatible option that satisfies the optimal parameters of the final prosthetic construction. From the study group we selected a representative clinical case for cardiovascular pathology in conjunction with partial edentulousness.The aim of this study is to identify how modern fixed prosthodontic technologies optimize the integration of fixed prostheses in the context of the current oral manifestations which occur as a consequence of different types of systemic damage.The study group consisted of 200 patients diagnosed with different forms of partial edentulousness and at the same time presenting different general status disorders. Non-invasiveness in conjunction with precise modern technologies with a different degree of biocompatibility creates the prerequisites for a good integration of oral rehabilitation against the background of different types of complications in the territory of oral manifestations in patients with different types of systemic diseases.

Keywords: systemic diseases, oral manifestations, partial edentulous, Co-Cr alloys , CAD/CAM technology

The onset of an important category of systemic diseases is manifested in the oral cavity by specific symptoms such as salivary disorders, swallowing disorders, changes in dental tissues, changes in the tongue and, last but not least, in the oral mucosa. This symptomatology suspected during the history and clinically evidenced by a careful dental examination, in the case of an undiagnosed patient with a general condition, the dentist can be among the first to notice these clinical signs, which known can help him to direct the patient to the specialist for diagnosis and treatment[1,2].

Monitoring the evolution of oral lesions can also lead to a prognosis regarding the evolution of a chronic disease.

Diabetes mellitus, heart disease, hemorrhagic syndromes, leukemia and respiratory pathology are among the conditions that pose particular problems in the usual practice of dentistry, because of the complications that can arise during dental treatment[3,4].

Atherosclerosis is a vascular pathology localized in the medium and large elastic muscular arteries, manifested by the appearance of an endothelial inflammatory state that will become chronic over time by thickening of the vascular lumen leading to

loss of arterial elasticity. It is the most common cause of death in the modern developed world. Risk factors include dyslipidemia, hypercholesterolemia, diet, chronic stress, smoking, a sedentary lifestyle, obesity, and high blood pressure[5,6].

In the oral mucosa, the epithelium becomes thinner, keratinized, the salivary glands atrophy, which leads to a decrease in salivary secretion, which always becomes more viscous, by increasing the percentage of mucin. Decreased salivary secretion is a primary cause of worsening cariogenic factors. Local factors, such as occlusal disorders (especially partial edentulousness and overcrowding of remaining teeth) and decreased oral hygiene, play a predominant role. The dental pulp changes its structure because vessels and nerve fibers are poorly irrigated by progressive obliteration of the apical phenomenon. Decreased vascularization and pulpal fibro calcareous degeneration decrease pulpal resistance to further aggression[7,8].

Any pulpal irritation causes the formation of amorphous tertiary dentin. This is abnormal, pathological dentin, most commonly tolerated without clinical signs. Dentin progressively becomes the site of sclerotic degeneration, its hyper calcification resulting in retraction of the dental tubules.

The enamel changes and becomes brittle, facilitating the appearance of abrasion at the occlusal surfaces and incisal edge[9,10].

Because of ischemic phenomena at the pulpal level and reduced sensitivity, these lesions are often not associated with painful phenomena. Oral manifestations of hypertension are mainly located in the oral mucosa. Thus, the labial mucosa is pink, slightly cyanotic due to the above normal concentration of reduced hemoglobin, hyperemia and congestion are observed in the papillae. The jugal mucosa is pinkish red. The lingual mucosa is slightly sabural. Enlarged veins on the anterior aspect of the tongue are common in elderly patients. In advanced forms, sublingual varicose veins may be a sign of essential hypertension and arteritis obliterans[11,12,13].

In stage II and III TAH, morphological changes of the periodontal vessels occur. In the diabetic patient we detect clinical manifestations, which influence the therapeutic algorithm. In the oral cavity, demineralization of hard dental tissues (rarefying osteitis), pathological mobility of teeth, pulp necrosis, hypokalemia, xerostomia, hypofunction of salivary glands, cracked lips with bleeding crusts, dry, lacquered jugal mucosa, depilated red tongue, raw apple halitosis and odor, abundant tartar deposits, parotid hypertrophy, diabetic gingivitis, chronic marginal periodontitis, ulcero-necrotic stomatitis, ulcero-necrotic gingivostomatitis, leukoplakia of the jugal mucosa, post-extractional alveolitis, post-extractional hemorrhages, mycotic stomatitis.

There is a close relationship between blood glucose levels and the development of periodontal pathology in diabetic patients, and periodontal signs and symptoms are currently considered the sixth complication of diabetes[14].

The therapeutic solutions chosen were ceramics on a zirconium support or ceramics on a metal infrastructure made by laser technique, which is a therapeutic alternative beneficial for the relationship with the affected tissues, a situation that is found in patients with cardiovascular or other types of general diseases. In addition to the technological line chosen, the biomaterials chosen are also extremely important, with Co-Cr alloys remaining a biocompatible option that satisfies the optimal parameters of the final prosthetic construction. From the study group we selected a representative clinical case for cardiovascular pathology in conjunction with partial edentulousness[15].

The aim of this study is to identify how modern fixed prosthodontic technologies optimize the integration of fixed prostheses

in the context of the current oral manifestations which occur as a consequence of different types of systemic damage.

The study group consisted of 200 patients diagnosed with different forms of partial edentulousness and at the same time presenting different general status disorders. Modern fixed prosthetic rehabilitation technologies can be anchored both in the non-metallic and in the metallic register using for the technological algorithm Exocade type computer programs that can provide accuracy both in the planning of the therapeutic solution and in its execution(Fig.1).

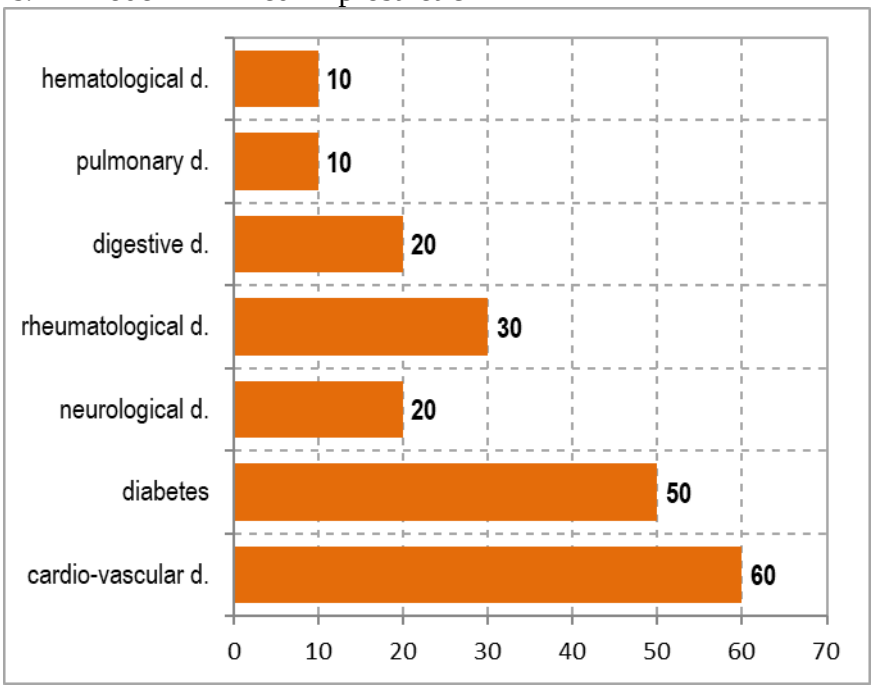


Fig.1.The repartition on general chronic pathologies of patients with partial edentulism

The high prevalence of cardiovascular disorders in the general population, especially the cardiac ischemic disease, constituted a pertinent starting point for the correlative aspects between the general pathology and the local pathology identified in our research.

Result and Discussions

Metal-ceramic crowns are a therapeutic solution frequently used in dental practice, due to the biological qualities of the ceramic materials, their biomechanical characteristics, but above all their outstanding aesthetic results. By combining the strength of alloys with the physiognomic properties of ceramic materials, it is possible to obtain prosthetic constructions with optimal mechanical characteristics and an appearance close to that of natural teeth[16-19.

Ongoing research in the field of biomaterials has enabled the development of biocompatible and physiognomic materials that provide strength as well as restore the physiognomic function that metal alloy crowns do not fully fulfil[20-25].

Mixed metal-ceramic restorations are an option of choice, thus the emphasis is on aesthetics and their fabrication by modern technologies, which are much more precise.

The metal-ceramic crown consists of the metal framework and the physiognomic component of plating.

The material used for the metal framework in the present case is a Realloy C metal-ceramic alloy, manufactured in Germany (Figure 1). This is a universal CO-Cr based bonding alloy compatible with all types of ceramic material; it is nickel-free, beryllium-free and meets EN ISO 22674 type 4 standards.Composition: Co 62,5% Cr 24,6% W 8,5% Mo 2,9% Si 1,3% and other elements <1%. The low Vickers hardness of 285 HV10 makes the alloy easy to machine and polish after casting, unlike other alloys.Recommended for use in combination with ordinary ceramics such as Ivoclar, DeTrey, Vita (Omega, VM13) or Ducera, with respect to the associated working instructions(Fig.2).

Fig. 2 Realloy C metallo-ceramic alloy

The biomaterials used in the fabrication of the physiognomic component were IPS Style Ceram, Ivoclar Vivadent system because they offer maximum efficiency, easy handling, and natural aesthetics. It contains oxyapatite crystals which are found in all the shaded components, from opaquer to incisal, allowing the translucency or opacity of the restoration to be controlled as desired.At the same time, the oxyapatite crystals reflect a large amount of the incident light, thus giving the restorations an appearance similar to natural tooth substance.

The additionally contained leucite and fluorapatite crystals as well as the coordinated glassy phases give this low-fusible ceramic handling and optical properties. It therefore exhibits optimized shrinkage and therefore high material stability during firing.

These materials are thus indicated for conventional single-layer or multi-layer veneering ceramics for the most popular dental alloys (including electroplated ones) with CTE ranging from 13.8-15.2 x 10-6/K (25-500 degrees C); facets on refractory (IPS Style Ceram only).Supplied as a kit containing layering powders, liquid, pastes and 2 shade keys(Fig.3).

Fig. 3 IPS Style Ceram Starter Kit A-D Ivoclar Vivadent

Patient S.T. aged 40, male,with cardiovascular deseases, presented to the dental clinic with major masticatory and esthetic function deficiencies, having vital lower arch teeth and unsightly. Following clinical and radiological examinations, the treatment solution proposed by the doctor and approved by the patient is the fixed ceramic prosthesis on metal framework.

Thus, the masticatory function is restored through the metal component that ensures strength, and the aesthetic function through the veneering component, ensuring the patient's integration into society. The prosthetic restoration will span maxillary 1.3 to 2.3 and mandibular 3.3-4.2.

After the clinical examination and establishment of the treatment plan follows the preparation of the teeth, both maxillary and mandibular for the application of mixed metal-ceramic aggregation elements, to provide the necessary space for the application of unidentate prostheses on organic substructures.

The preparation requires a sacrifice of 1.5-2 mm of amelo-dental substance to allow a thickness of 0.3-0.5 mm for the metal component and 1.2-1.5 mm for the physiognomic component.After the preparation of the model, a series of steps will follow to create the model of the metallic infrastructure, which will be made by the modern method, using Cad-Cam technology. The next step is to scan the models (Fig.3) in a special enclosure using a mobile arm scanner. The models were placed on a support that keeps the model stable, and in order to have all the details contained by the scanner and to avoid light interference, a layer of occlusion spray was deposited on the models.

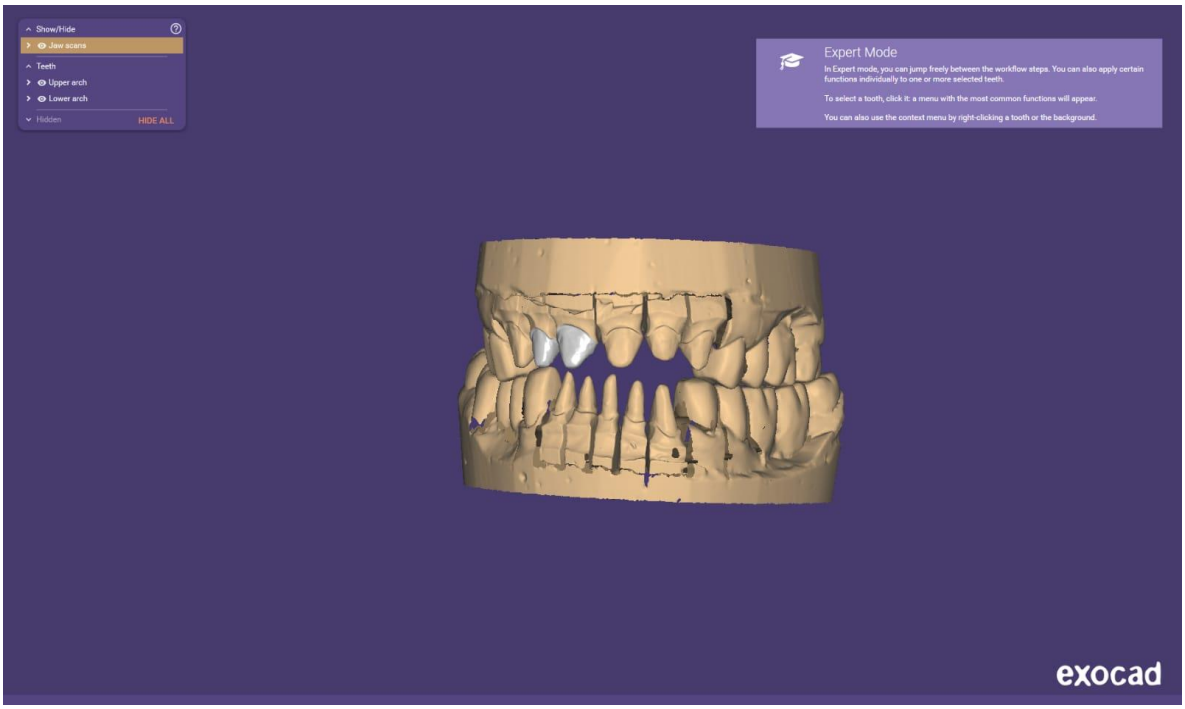


Fig. 3. Scanning the upper and lower model

After scanning all areas of interest, a virtual model was set up in the software, which is a faithful copy of the models, i.e., the prosthetic field.

Next, the worksheet was created for the case in question, where the following data was entered: doctor's name, patient's name, and technician's name. In filling in these data, the following features will be selected: for the aggregation elements, offset copying will be selected and for the bridge bodies, reduced pontic will be selected, with a color assigned to each of them. The next step is to draw the parcel line (Fig.4) in order to define as precisely as possible, the boundary of the bridge and the parcel line of the future work. The line is drawn from close to close with the possibility of correcting any errors.

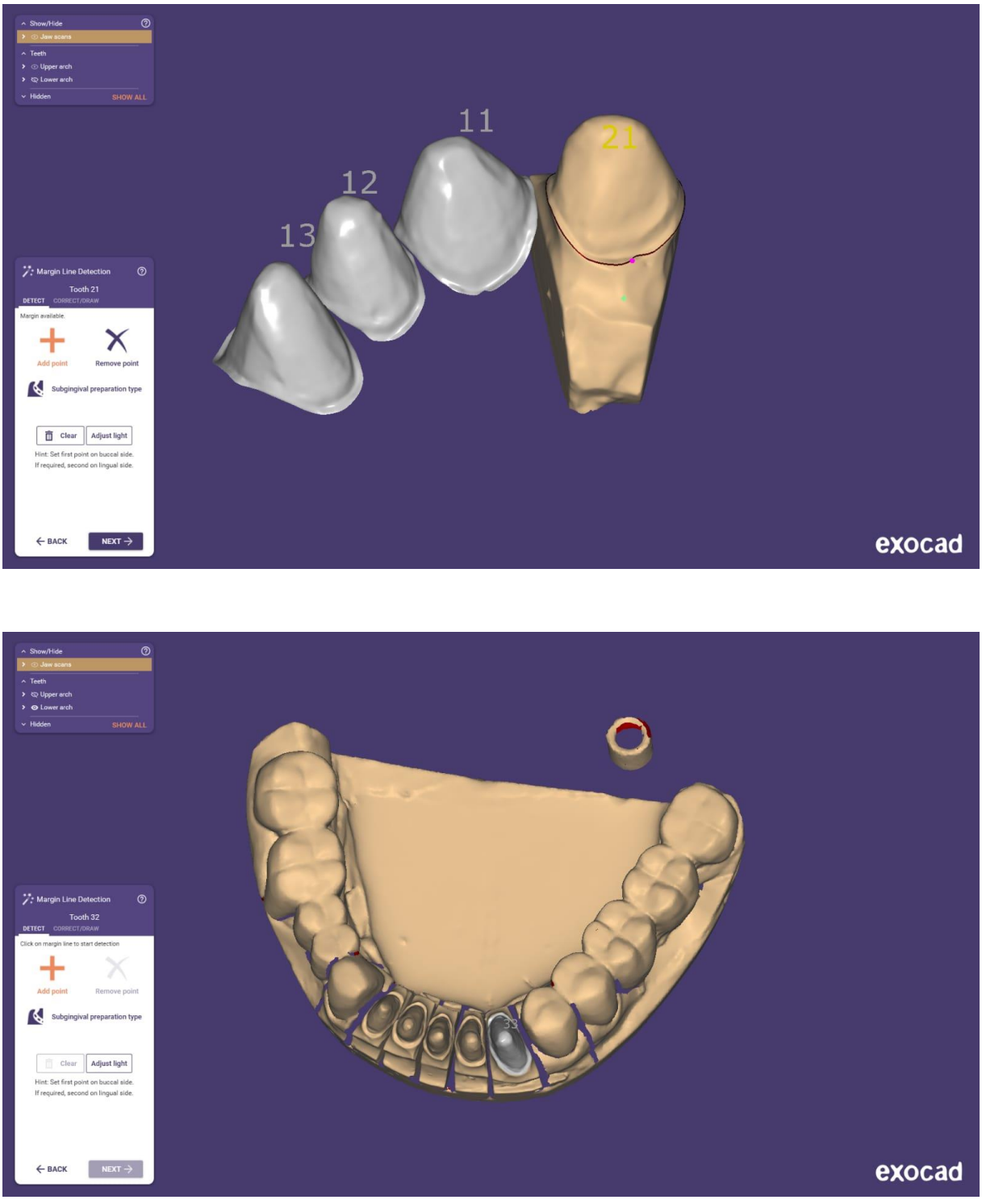


Fig. 4 Digital aspects of tracing collars

Establishing the insertion axis and the thickness of the layout of the future metallic infrastructure. The software also allows the determination of the space between the abutment and the infrastructure required for the cementing (Fig.5).Thus, the cementing space is selected equal to 0 at the level of the abutment teeth and the height of 1 mm; towards the incision the cementing space will be equal to 0.03 mm. The cementing space is represented by certain colors, green for the space in the area of the collar, yellow for the rest of the surface of the prosthetic abutment.

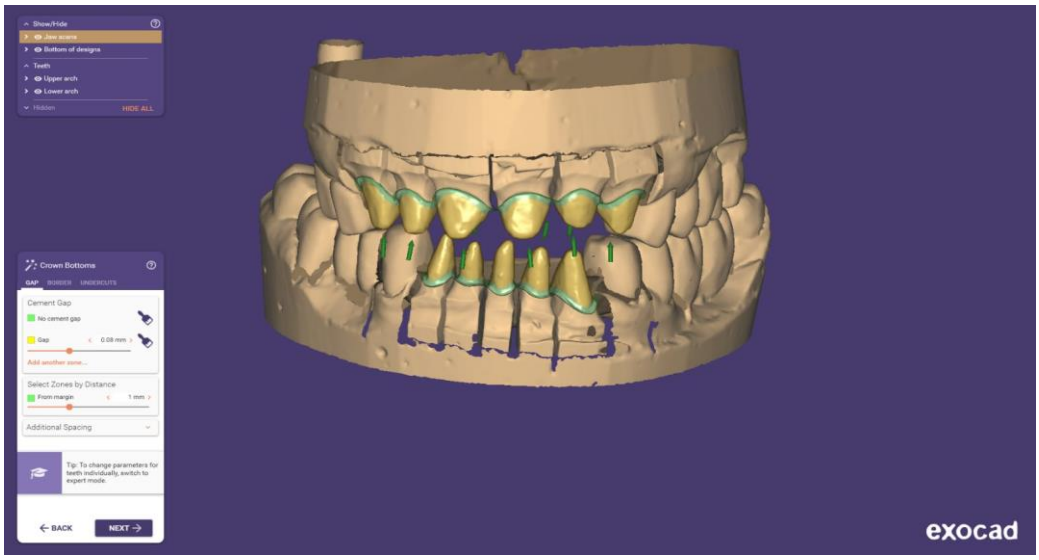
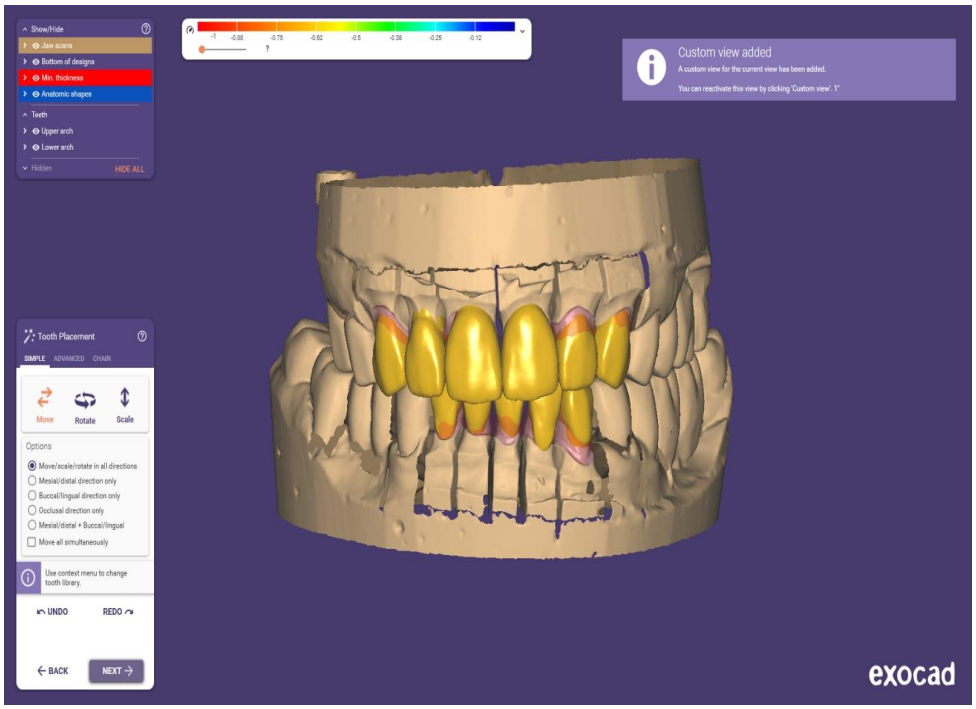


Fig. 5 Setting the cementing space

The next step is the automatic generation of the minimum caps by the software to set the size (Fig. 6).



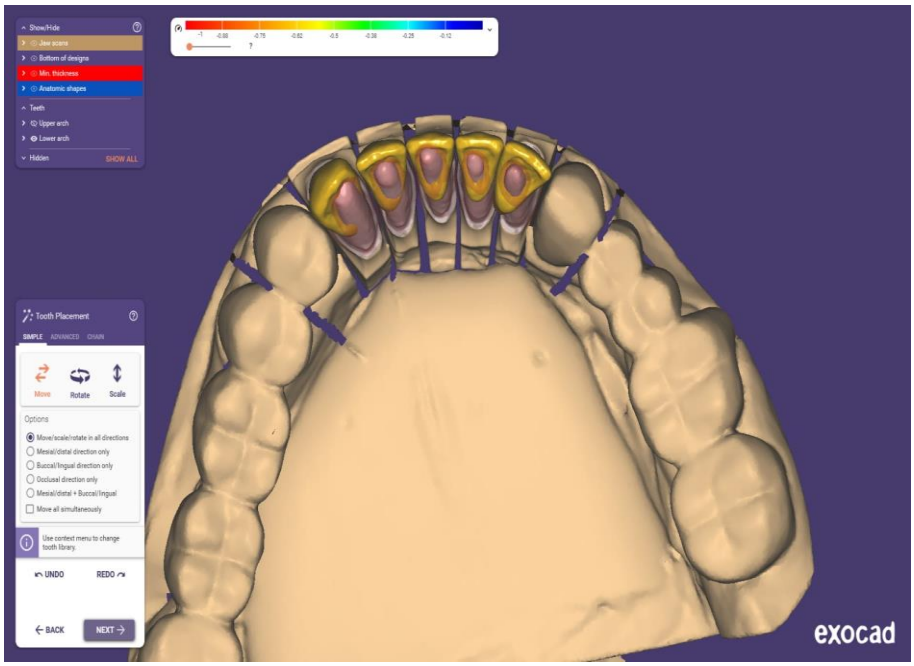


Fig. 6 Generating caps at minimum by software

In this way the dental technician can customize the design by using the functions in the table on the left-hand side of the page.

Caps are individualized by the free function, which consists of the following settings: plus for addition, minus for deletion and smooth for smoothing. At the same time, the type of intermediate is chosen (with or without morphology) and connectors are designed, which are used to join the caps and the bridge body between them.

The connectors can be individualized by thickness, height by means of the table.

The final mock-up will consist of a single element. The design of the final mock-up will be made by progressive addition of the mock-up resin(Fig.7).

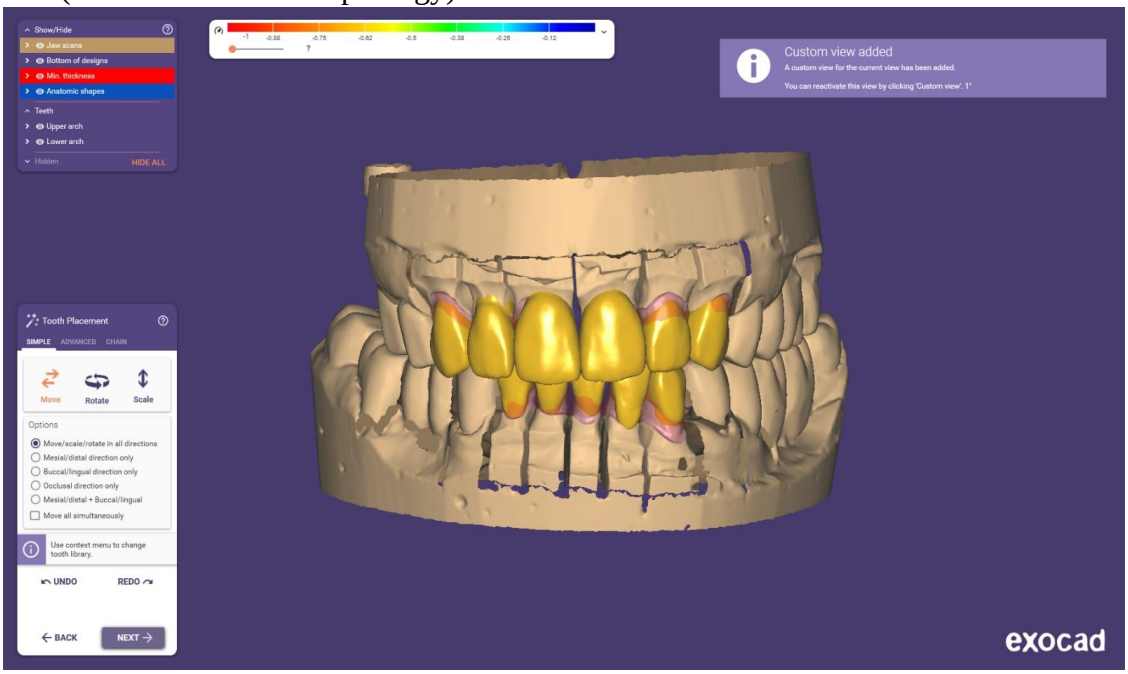


Fig. 7 Final layout design

When the design is finished, everything is saved to the hard disk. The actual model will then be printed using the Asiga Composer 3D printer, and the model will be placed on the printer platen (printing plate).

Conclusions

Non-invasiveness in conjunction with precise modern technologies with a different degree of biocompatibility creates the prerequisites for a good integration of oral rehabilitation against the background of different types of complications in the territory of oral manifestations in patients with different types of systemic diseases.

Mixed metal-ceramic restorations are the most common form of treatment in fixed prosthetic restorations, following all-ceramic restorations, which have limitations due to the complexity of the technological equipment and the costs.

At the same time, the CAD/CAM technology used by us is state-of-the-art and involves obtaining high-precision metallic infrastructures, time savings, and a better vision of the various clinical situations in the dental field.

The therapeutic design plan for dental bridges follows certain biological and mechanical objectives, both at the level of the bridge body and the aggregation elements.

References

1. Saini R., Saini S., Saini S.R. Periodontal diseases: a risk factor to cardiovascular disease. Ann Card Anaesth. 2010;13:159–161.
2. Park K. 23rd edition. 2016. Park's textbook of Preventive and Social Medicine.
3. Hogan J., Radhakrishnan J. The assessment and importance of hypertension in the dental setting. Dent Clin North Am. 2012;56:731–745.
4. Kahri J., Rapola J. Cardiovascular disorders in dental practice. Nor Tannlegeforen Tid. 2005;115:84–90.
5. Xavier FM, Ferraz MP, Marc N, Escosteguy NU, Moriguchi EH. Elderly people's definition of quality of life. Rev Bras Psiquiatr 2003;25:31-39.
6. Steele JG, Sanders AE, Slade GD, Allen PF, Lahti S, Nuttall N, et al.. How do age and tooth loss affect oral health impacts and quality of life? A study comparing two national samples. Community Dent Oral Epidemiol 2004;32:107-114.
7. Seildl EM, Zannon CM. Quality of life and health: conceptual and methodological issues. Cad Saude Publica 2004;20:580-588.
8. Brondani MA, MacEntee MI. The concept of validity in sociodental indicators and oral health-related quality-of-life measures. Community Dent Oral Epidemiol 2007;35:472-478.
9. Antoniac, I., Miculescu, M ., Manescu, V., Stere, A., Quan, P.H., Paltanea, G .Robu, A ., Earar, K., Magnesium-Based Alloys Used in Orthopedic Surgery, Materials, 2022, Volume 15, Issue 3
10. Atchison KA, Andersen RM. Demonstrating successful aging using the International Collaborative Study for Oral Health Outcomes. J Public Health Dent 2000;60:282-288.
11. Barnfather KD, Brunton PA. Restoration of the upper dental arch using Lava all-ceramic crown and bridgework. Br Dent J 2007;202:731-735.
12. Donovan TE. Factors essential for successful all-ceramic restorations. J Am Dent Assoc 2008;139:14S-18S.

13. Asaftei, I.V., Earar, K., Birsa, L.M., Sandu, I.G. ,Lungu, N.C. , Sandu, I. , Conversion of Light Hydrocarbons with Butanes and Butenes from Petroleum Refining Processes Over Zn-HZSM-5 and ZnO/HZSM-5 Catalysts, Revista de chimie, Volume 66, Issue 7,2015
14. Denry I, Kelly JR. State of the art of zirconia for dental applications. Dent Mater 2008;24:299-307
15. Bandéca MC, Nadalin MR, Calixto LR, Saad JR, da Silva SR. Correlation between oral health perception and clinical factors in a Brazilian community. Community Dent Health 2011;28:64-68
16. Walton TR. An up to 15-year longitudinal study of 515 metal-ceramic FPDs: Part 2. Modes of failure and influence of various clinical characteristics. Int J Prosthodont 2003;16:177-182.
17. Pontoriero R, Carnevale G. Surgical crown lengthening: a 12-month clinical wound healing study. J Periodontol 2001;72:841-848.
18. Polack MA. Restoration of maxillary incisors with a zirconia all-ceramic system: a case report. Quintessence Int 2006;37:375-380.
19. Vasluianu, R .,Forna, D.A. ,Zaltariov, M ., Murariu, A , In vitro Study Using ATR-FTIR Methode for Analyze the Effects of the Carbamide Peroxide on the Dental Structure ,Revista de Chimie, 67 (12) , 2016 , pp.2475-2478
20. Shirakura A, Lee H, Geminiani A, Ercoli C, Feng C. The influence of veneering porcelain thickness of all-ceramic and metal ceramic crowns on failure resistance after cyclic loading. J Prosthet Dent 2009;101:119-127.
21. Donovan TE, Chee WW. Cervical margin design in contemporary esthetic restorations. Dent Clin North Am 2004;48:417-431.
22. Popescu, V .Vasluianu, E ., Forna, NC , Sandu, I ., Bercu, E ., Comparative Study of the FTIR Analysis and the Performances of N,N,N-trimethyl Chitosan as Wrinkle-proofing Agent, Revista de Chimie,,Volume 64,Issue11, 2013,Page1284-1294
23. Goursand D, Paiva SM, Zarzar PM, Pordeus IA, Grochowski R, Allison PJ. Measuring parental-caregiver perceptions of child oral health-related quality of life: psychometric properties of the Brazilian version of the P-CPQ. Braz Dent J 2009;20:169-174.
24. Bolat, M., Nicolae, B.D., Baciu, E.R. ,Forna, D.A . Bosinceanu, D.G. , Forna, N.C. , Partial dentures-succeses and failures, Romanian Journal Of Oral Rehabilitation, Volume 9,Issue 4 , 2017, Page 93-96
25. Fernandes MJ, Ruta DA, Ogden GR, Pitts NB, Ogston SA. Assessing oral health-related quality of life in general dental practice in Scotland: validation of the OHIP-14. Community Dent Oral Epidemiol 2006;34:53-62.