Comparison of hygiene levels in metal-ceramic and stratified zirconia in prosthetic rehabilitation on teeth and implants: a retrospective clinical study of a three-year follow-up

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The aim of this retrospective clinical study was to evaluate and compare oral hygiene levels in patients subjected to fixed metal-ceramic or stratified zirconia prostheses, either on teeth or on dental implants. Twenty patients, including 10 with metal-ceramic prostheses and 10 with stratified zirconia, were engaged for the study. Considering the prosthesis positioning phase as zero time, all patients were examined twice a year for a follow-up period of 3 years. During each session, to assess oral cavity state of health, both the Plaque Index (IP) and the Bleeding Index (BOP) were recorded. All patients were instructed in home hygiene maintenance and subjected to professional oral hygiene sessions customized according to prothesis type (on natural teeth or dental implants) and materials (metal ceramic or stratified zirconia). Statistically significant evidence was found in IP values, with an increase in the initial stages in zirconia prostheses and in the final stages in metal-ceramic ones. BOP levels showed a reduction during the follow-up period, but no statistically significant differences were found between examined groups. An adequate patient education in hygiene maintenance associated with professional oral hygiene sessions with special tools could positively affect fixed prostheses' maintenance, both on natural teeth and on dental implants.

In case of tooth compromise, based on quality and quantity of residual dental substance, fixed dental prothesis or implant-supported fixed prothesis could be considered as possible alternatives (1-2).

As suggested by several Authors long-term success and patients' satisfaction could be obtained both in osteo integrated dental implants or in dental supported fixed prosthesis (3-5). Several materials as metal-ceramic or zirconia could be applied for fixed prosthodontic treatment such as single crowns or full arch rehabilitation. As traditionally the first material was considered as gold standard, metal-free restorations were increasingly required, both for biocompatibility and mechanical and aesthetic properties (6, 7). Long term complications could occur in both restorations, either on teeth or on implants (8), such as ditching of cement margin, screw loosening, prosthetic cracking or fracture could be defined as technical complications, also biological issues as periodontal diseases could compromise prosthodontic treatment (9, 10).

Although periodontitis could be defined as multifactorial pathology, bacterial plaque could be considered as main biological cause (11). As

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dental plaque could accumulate either on tooth crown or under gum margin, that is in subgingival area of the sulcus or pocket, professional hygiene sessions based on specific devices used according with rehabilitation type could be considered as gold standard so as to prevent occurrence and progression of mucositis, peri-implantitis, bleeding on probing (BOP), and deep probing pocket depth (PPD) (12, 13). Oral hygiene instructions provided by dental professionals, in association with patient compliance, seems to have a key role in the success of prosthetic rehabilitation, both on natural teeth and on dental implants (14, 15).

The aim of this retrospective clinical study is to evaluate and compare oral hygiene levels in patients subjected to fixed metal-ceramic or stratified zirconia prostheses, either on teeth or on dental implants, to prove role of oral professional hygiene sessions and patients' education and monitoring in different prosthetic rehabilitation.

MATERIALS AND METHODS

From November 2017 to December 2020, twenty patients, without distinction between men and women, were engaged in this study in the Dentistry Department of San Raffaele Hospital (Milan, Italy). Patients with uncontrolled systemic diseases, smokers or taking plaque-building drugs or anticoagulants, which could promote bleeding, were excluded from research. All patients were evaluated with careful objective, radiological and functional initial examination.

The patients received a prosthetic or implant-prosthetic rehabilitation designed and finalized according to the actual protocols and in compliance with the aesthetic and functional plans of the patient. A correct evaluation of the present bone structure, of the residual natural elements and of the occlusal planes was performed (16). The aesthetic-functional needs of the patient were also taken into consideration.

All patients were designed using traditional and digital methods to support them: the functional aesthetic design subsequently guided both the provisional and definitive planning phases (17, 18). In according to the reduction of the existing bacterial load, all the patients were subjected to chlorhexidine rinses (19, 20). Furthermore, the respect of the tissue healing based on a correct initial evaluation of the healing state of the tissue of the patient, especially in the pandemic actual situation, is necessary to evaluate the inflammatory state of the oral cavity before a prosthetic or surgical treatment (21, 22).

The sample was divided into two groups: the first group consisted of ten patients with zirconia prostheses, the second of as many subjects with metal-ceramic prostheses. For each subgroup five had prosthetic restorations on implants and five on natural teeth. Patients taking plaque-building drugs or anticoagulants, which could promote bleeding, were excluded from research. All patients recruited for this study have been visited twice a year from December 2017 to November 2020, starting from the first day the prosthesis was placed.

During every check, using special tools such as Teflon curettes for implant instrumentation, peek inserts for ultrasonic scalers, powders with low particle size applied for air-polishing and super-floss for cleaning under prosthesis and around implant' or teeth' sites, professional hygiene was performed.

Two clinical indices were recorded during each session: Plaque Index (PI) and Bleeding Index (BOP). For the detection of Plaque Index (IP), fluorescein was used, a plaque detector that is applied to all prosthetic surfaces with the aid of a micro-brush. Through the chemical process given by the reaction of the dye in contact with the bacterial plaque and thanks to the use of a blue light LED lamp; we can observe the areas with the greatest presence of soft deposits. The Plaque Index as a percentage was obtained using the Plaque Control Record technique, which allows the registration of bacterial plaque on the individual prosthetic surfaces, dividing the tooth into four zones: vestibular, palatal/lingual, mesial and distal.

After examining and recording all the surfaces, the index is calculated by dividing the number of surfaces with the presence of plaque by the total number of available surfaces. The bleeding index (BOP) was obtained by examining the presence or absence of bleeding on the four surfaces described

above, following the passage of the periodontal probe in the gingival sulcus. After examining and recording all the surfaces, the index was calculated by dividing the number of surfaces with bleeding by the total number of available surfaces. After the acquisition of clinical indices and therefore after noting the improvement or worsening of the patient's level of health; detailed and individualized instructions were provided for each patient on the use of home aids such as manual toothbrush with soft bristles, electric toothbrush with soft bristle head, Super-floss dental floss for cleaning the implants and the spaces under the prosthesis and interdental brushes specific for each patient. The instructions that were given to patients were always accompanied by a reinforcement of motivation to carry them out.

In each recall session, the patient was advised to go to the clinic with their home aids, in order to monitor their use by the same. The plaque index value and any negligence with respect to the correct use of home aids, led us to perfect the maneuvers performed by the prosthetically rehabilitated patient. At the end, patients were advised not to consume too hard foods in order not to risk fracturing or chipping the prosthesis, causing damage as well as aesthetic and functional damage. Another category of foods to be taken with care are chromogenic ones such as: coffee, tea, red wine, which would pigment the prosthetic material, creating aesthetic damage.

RESULTS

Plaque Index (IP)

Plaque Index results were recorded every 6 months for a 3-year follow-up period both for the first group, i. e. patients with zirconia prostheses (Table I), and for the second, i. e. with metal-ceramic devices (Table II).

A Multivariate Analysis of Variance (MANOVA) revealed a statistically significant difference, over time, in the trend of the IP values in the two groups, F=2.79, p=.022 (Fig. 1). In particular, the IP values

Table I. *Average values of Plaque Index (IP) detected every 6 months for 3 years in zirconia rehabilitations.*

	Average	*Standard deviation*
IP0	27.80	6.72
IP1	28.00	6.12
IP2	27.20	4.51
IP3	22.40	3.09
IP4	21.60	6.20
IP5	15.70	3.91

Table II. *Average values of Plaque Index (IP) detected every 6 months for 3 years in metal-ceramic rehabilitations.*

	Average	*Standard deviation*
IP0	27.80	7.34
IP1	25.60	4.99
IP2	24.70	4.02
IP3	23.20	4.26
IP4	21.10	3.87
IP5	19.60	3.80

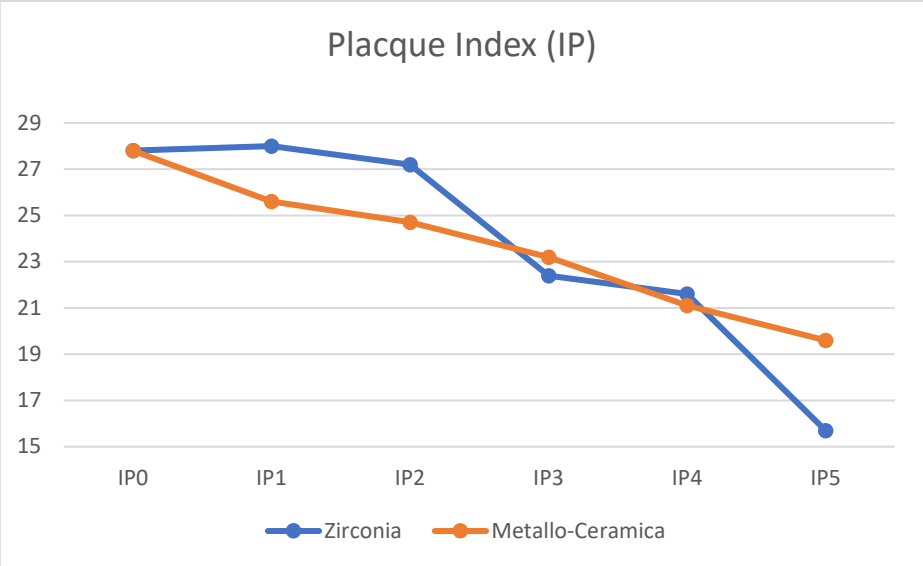

Fig. 1. *Trend of the average values of the Plaque Index (IP) in zirconia vs metal-ceramic restorations over 3 years.*

Table III. *Average values of Bleeding Index (BOP) detected every 6 months for 3 years in zirconia rehabilitations.*

	Average	*Standard deviation*
BOP0	7.20	3.59
BOP1	5.60	2.06
BOP2	4.90	1.93
BOP3	2.90	1.62
BOP4	6.00	1.74
BOP5	2.50	1.02

detected in the Zirconia group are greater than those detected in the Metal-Ceramic group in the initial stages; these values are inverted, however, in the final survey phase.

Bleeding Index (BOP)

Bleeding Index (BOP) results were recorded every 6 months for a 3-year follow-up period both for the first group, i.e., patients with zirconia prostheses (Table III), and for the second, i.e. with metal-ceramic devices (Table IV).

A Multivariate Analysis of Variance (MANOVA) revealed a statistically significant difference in the trend of BOP values over time, F=4.49, p=0.048 (Fig. 2), without however highlighting appreciable differences between the two groups. In other words, BOP significantly decreases, over time, in both groups.

DISCUSSION

Clinical application of fixed prostheses, both on natural teeth and on implants, could be a valid therapeutic alternative to removable prostheses (1, 2). To evaluate teeth maintenance, several criteria as residual coronal substance, abutment's retention and resistance, periodontal attachment loss and furcation involvement, residual probing pocket depth,

Table IV. *Average values of Bleeding Index (BOP) detected every 6 months for 3 years in metal-ceramic rehabilitations.*

	Average	*Standard deviation*
BOP0	13.30	3.59
BOP1	9.20	2.06
BOP2	9.90	1.93
BOP3	10.90	1.62
BOP4	6.90	1.74
BOP5	3.40	1.02

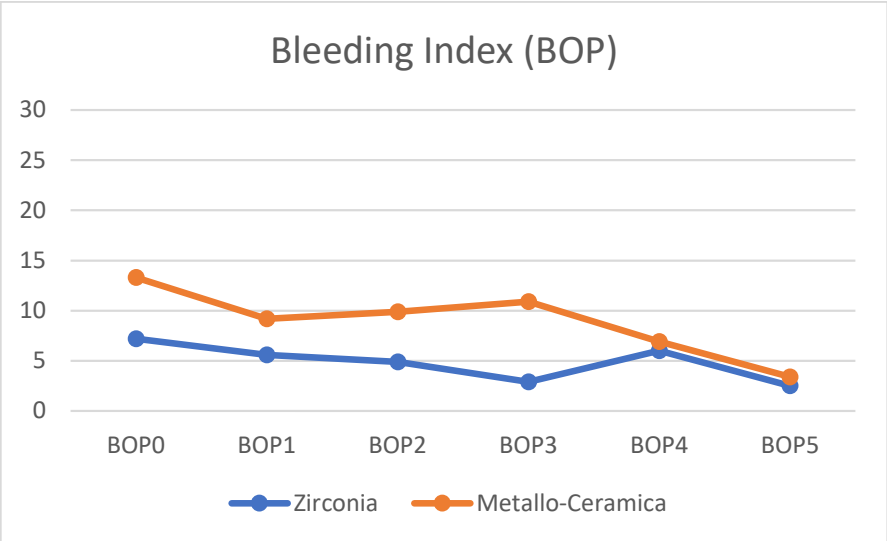

Fig. 2. *Trend of the average values of the Bleeding Index (BOP) in zirconia vs metal-ceramic restorations over 3 years.*

absence of clinical signs and symptoms or periapical radiolucency in endodontic treated elements, and contraindications in implants placement, could be considered (23-27). In case of tooth loss or need of tooth extraction, osteo integrated dental implants could represent a possible alternative for replacing missing teeth, restoring loss function (28).

Long-term success criteria of fixed prosthetic rehabilitation product could be summarized as follows: ability to reproduce the dental function, good aesthetics, accessibility at every point for hygienic maintenance by the patient and the dental hygienist, no interference with techniques cleaning of the remaining natural teeth, respect for oral tissues and acceptable aesthetics (29-31). Interproximal spaces should be broad enough to allow patients to introduce devices for interproximal hygiene (32).

Prosthetic margins should reproduce those of the underlying tooth, or to provide better access if it was not originally present (33). The prostheses should have adequate construction characteristics in order to allow self-cleansing and oral hygiene at home (34).

Long-term success could be associated both with prothesis features and with periodontal health (35), as well as stabilization of function with proper occlusal balance. As inflammatory process as gingivitis,

mucositis and periimplantitis could be considered as the most common biological complications of fixed dental prosthesis, both in provisional and definitive phase, several conditions as plaque accumulation and inflammation signs should be early intercepted (36-38).

Subjecting patients to a monitoring protocol and professional oral hygiene sessions could be the key to the success of fixed prosthetic restorations, both on natural teeth and on implants (14).

During professional oral hygiene sessions, the use of specific clinical parameters and devices customized according to the type of rehabilitation, could reduce risk of prosthetic failure (39-41).

Clinical parameters as Plaque Index and Bleeding Index, could allow both to early identify the accumulation of bacteria potentially harmful to the periodontium in natural teeth and in the peri-implant area, and to intercept possible inflammatory state of evaluated sites (42, 43).

As decompensated systemic diseases could interfere both with long-term fixed prosthetic success, predisposing patients to inflammatory reactions, the exclusion of these subjects from fixed rehabilitation could be essential (44, 45). However, if these pathologies are stably controlled, no statistically significant differences were found between sick patients and healthy patients in detection of clinical parameters considered (46, 47). Another factor that could adversely affect the long-term success of fixed rehabilitations is adequate patient education by the dental hygienist and proper compliance and ability in cleaning dental and gingival surfaces surrounding prosthetic crowns (48, 49). Maintain a continuous control regime over time, intercept any anomalies or inadequate oral hygiene conditions in the bud, so as to be able to intervene promptly to recreate the optimal conditions for prolonging prosthetic success (50). Failure to comply with these rules, even in the presence of a perfect prosthetic rehabilitation, could inevitably lead to the reduction of its survival in the oral cavity, leading to patients' dissatisfaction and discomfort.

Following the statistical analysis of the data collected, a progressive and continuous improvement of the clinical indexes detected in the 3 years on prosthetically rehabilitated patients could be evident. In detail, it could be seen how the Plaque Index (IP) in both materials starts with similar values while at the time of the last visit the rehabilitations on zirconia achieve better results. As for the Bleeding Index (BOP), however, zirconia maintains, albeit slightly, lower and lower values than metal-ceramic, without however highlighting appreciable differences between the two groups. The difference between implant rehabilitation vs rehabilitation on a natural element was found through the observation of the IP and BOP indices collected during the sessions, a continuous improvement in both rehabilitations, following each six-month visit over the three years. Following the indices' collection, in the last visit the values were slightly lower in the rehabilitations on natural teeth; however, it should be considered that the study was carried out on a small number of samples, therefore the specific analyzes on the comparison of the level of hygiene between implants rehabilitation comparison natural tooth would deserve further study.

Within the limitations of this study, based on obtained results, the authors agree professional and home oral hygiene maintenance, in association with constant monitoring through clinical parameters, could be considered essential for long-term success on both zirconia and metal-ceramic prosthetic products. Of great importance was certainly the continuous and in-depth education provided to patients at each visit, in conjunction with periodic motivational reinforcement.

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