

EVALUATION OF PROSTHETIC QUALITY AND MASTICATORY EFFICIENCY IN PATIENTS WITH TOTAL REMOVABLE PROSTHESIS: STUDY OF 12 CASES

M. CORSALINI¹, D. DI VENERE¹, P. SPORTELLI¹, D. MAGAZZINO¹, C. RIPA¹, F. CANTATORE¹, G. CAGNETTA¹, C. DE RINALDIS², N. MONTEMURRO³, A. DE GIACOMO⁴, A. LAFORGIA¹, B. RAPONE⁵

¹ Interdisciplinary Department of Medicine (DIM) - Section of Dentistry, "Aldo Moro" University of Bari, Bari, Italy

² Freelance

³ Unit of Neurosurgery, "Di Venere" City Hospital, ASL Bari, Bari, Italy

⁴ Child Neuropsychiatry Unit, Department of Basic Medical Sciences, Neuroscience and Sense Organs, "Aldo Moro" University of Bari, Bari, Italy

⁵ Department of Basic Medical Sciences, Neurosciences and Sense Organs, "Aldo Moro" University of Bari, Bari, Italy

SUMMARY

Purpose. The World Health Organization estimated edentulism rates ranging from 6 to 69% all over the world, and from 15% to 78% in Europe. In Italy, edentulism is more diffuse among women, especially from the age of 70. Since, women with an average age of 75 or above may reach rates of up to 52.2%, against the 47.6% of men. Non-rehabilitated edentulous people represent a scarce percentage in our country, only the 5% between over 70s. Total conventional removable prostheses remain the main treatment for edentulism, even though alternative techniques such as implant-prosthesis exist. Our study evaluated the patients' masticatory efficiency and the quality of both superior and inferior total mobile removable prostheses implanted in those 12 individuals. Furthermore, the relationship between prosthesis quality, prosthesis age and masticatory strength and efficiency has been taken into consideration.

Materials and methods. Our study analysed total removable superior and inferior prosthetic rehabilitation in 12 completely edentulous patient cured by the Dental School's prosthesis department of Bari University. Our analytic methods comprehended: state evaluation criteria to assess objective prosthesis quality; subjective questionnaire about masticatory ability; colour mixing test, a colorimetric test of the chewing gum with double colour to evaluate masticatory efficiency. We found a direct connection between prosthesis quality, prosthesis age and masticatory efficiency. The subjective evaluation questionnaires gave a general idea about patient's masticatory ability, although biased towards the adaptation level of each patient. The relation between prosthesis' quality and its age-related usage has highlighted a decrease in total removable prostheses' quality accompanied by its increasing age-related usage.

Results. From the colorimetric test, we can infer that the analysed masticatory efficiency is correlated with prosthesis quality and age. The data obtained about the prosthesis' quality are based on subjective evaluation through a questionnaire, which is influenced by the adaptation of the patient's alimentary habits over time; the questionnaire consisted in asking the patient about the difficulty level in chewing food of low, medium or hard consistency. Patients tend to substitute aliments they cannot chew/ingest with another aliment. Our study has emphasised a correlation in the relationship between the prosthesis' quality and its age-related usage, showing a decrease in the total mobile prosthesis' quality accompanied by its increased age-related usage. In particular, the quality is noticeably reduced after 10 years, which can be considered the average life of a prosthetic artefact if exposed to periodic check-ups and maintenance.

Conclusions. Prosthesis quality needs to be evaluated over a wider range of cases. Hopefully in the near future, both quality evaluation criteria of total mobile prosthesis and the test to determine their masticatory efficiency will be effectively and broadly used in an objective manner, with the goal of improving prosthesis performances.

Key words: total removable prosthesis, masticatory efficiency, prosthetic quality, chewing gum.

Introduction

Edentulism is defined as the complete loss of permanent dentition; it results from a multifactorial process determined by biological (e.g. caries, periodontal diseases, poplar pathology) and non-biological factors (trauma, socio-economic conditions, hygiene, previous dental treatments) (1).

The World Health Organization stated "Caries" as a phenomenon of worldwide dimensions, while periodontal disease is diffused among 5%-10% of world population. The latter chronic oral condition appears to determine the complete loss of permanent dentition.

Edentulism prevalence and distribution are correlated with cultural, individual and socio-economic factors. The WHO estimated edentulism incidences ranging from 6 to 69% all over the world, and from 15 to 78% in Europe, mostly among elder people starting from 65 years old (2). Periodontal diseases develop chronically and can affect subjects of all ages. They determine a progressive impairment and reduction of support tissues, periodontal ligament and alveolar bone followed by dental element loss.

In Italy, edentulism is more diffuse among women, especially from 70 years old: in between women over the age of 75s the rate reaches 52,2%, against the 47,6% within men. Non-rehabilitated edentulous people represent a scarce percentage in our country: only 5% between over 70s. The worsening of general health condition and the appearance of systemic diseases - such as diabetes, immunodepression and osteoporosis - are closely related to an increased edentulism risk. In between unhealthy habits, smoking is linked with edentulism onset: edentulous smokers double the number of edentulous non-smokers (3).

Tooth loss activates bone resorption and progressive alveolar processes loss (4). In general, degree of bone atrophy is inversely related to timing of edentulism onset: the more premature

the dental element loss, the higher the degree of bone atrophy. The duration of removable prosthesis use is inversely related to bone atrophy degree, which is higher when the prosthesis is inadequate. Dental element loss is associated with depletion of periodontal system's intrinsic proprioceptive sensibility: this causes the disappearance of the feedback system based on motor coordination and masticatory acts.

Edentulism affects patients' quality of life: it reduces masticatory efficacy and alters language, which represent two fundamental daily activity for the patient's psychophysical health. Total conventional removable prostheses remain the main treatment for edentulism, even though alternative techniques such as implant-prosthesis exist.

Clear majority of patients are satisfied with the use of a total removable prostheses; nonetheless a small minority may express dissatisfaction due to reasons such as scarce prosthesis quality and subjective adaptations (psychological, behavioural, biological, and allergenic factors) (5-33).

Total mobile prostheses are recommended to elderly people because they offer good aesthetics and a comfortable chewing, apart from being economical.

The prosthesis needs regular check-ups once every 4-6 months. In addition to pain, an unstable prosthesis can determine anatomical alterations of hard and smooth tissues. The side effects of the removable prosthetic treatment can be systemic, local, temporary and permanent. Systemic side effects comprehend severe motor incoordination, psychosis or severe dementia accompanied by possible traumatic events and accidental swallowing (34); local side effects comprehend chronic mucosal pathologies or presence of copious torus palatinus or mandibularis. Quality check-up is fundamental to guarantee a perfect outcome of the treatment plan. The patient is satisfied of prosthesis quality when certain criteria are satisfied. The patient should not have any difficulty in food shredding and swallowing and should regain the previous level of quality of life; the prosthesis should improve

phonetics and should integrate as much as possible with the patient's physiognomy; prosthesis configuration should facilitate the acceptance of an exogenous corpse; hygiene and maintenance should be easily controlled.

Masticatory function can be defined as the capacity to chew food: teeth, tongue, cheeks, lips, masticatory muscles, saliva and neuromuscular system represent a group of element that allows to carry out this function. The number of residual elements, the number of occluding couples, teeth morphology and the total area of occlusal antagonist surfaces determine the masticatory function. Prostheses can partly compensate loss of masticatory function. During chewing, masticatory muscles allow mandibular movements; greater muscular activity has been reported when chewing food of hard consistency. Objective masticatory function - defined as "masticatory efficiency" - has been measured during the years to determine each person's capacity to shred and reduce food to small pieces so it can be used as a test for a given number of masticatory cycles. Independently from their age, adults with complete dentition report higher masticatory efficiency; the loss of few posterior elements implies a significant masticatory efficiency reduction (35, 36). Treatment results and patient's adaptation to total prostheses must be evaluated by considering patients' comfort and masticatory efficiency. Relevant prosthesis success factors include: prosthesis quality, which is detectable with objective criteria (37); patient's comfort, which is detectable with masticatory efficiency test; maintenance or restoration of vertical occlusion dimension; aesthetics restoration.

Various authors support the use of standardized criteria to evaluate total prosthesis quality; Sato et al. proposed a reproducible index based on certain criteria in order to realize an objective analysis over prosthesis quality (37). Various studies demonstrate that both patient's oral condition and total prosthesis' quality can influence masticatory efficiency. From the fourth year of prosthesis use and particularly after the eighth year, a high number of patients displays masticatory problems. Substituting worn out prosthe-

ses with new prostheses leads to an increase in masticatory efficiency (38). Mobile prosthesis' scarcity in quality is often due to patients insufficiently valuing the importance of check-ups and to prosthesis maintenance, carried out by both patient and professional dentist. Periodic check-ups are important: apart from artefact evaluation, supporting tissues must be analysed. Mobile prostheses need periodic readjustment due to artificial teeth wear, bone resorption and resins' porosity (39).

Our study analysed the patient's masticatory efficiency and the quality of both superior and inferior total mobile removable prosthesis implanted in 12 patients. Furthermore, the relationship between prosthesis quality, prosthesis age and masticatory strength and efficiency has been taken into account.

Materials and methods

We analysed the total mobile superior and inferior prostheses belonging to 12 patients supplied by the dental prosthesis Department of Dental School of Bari University by using:

1. State evaluation criteria for objective quality evaluation
2. A subjective questionnaire about masticatory ability
3. Colorimetric chewing gum test with double colour: colour mixing test, for masticatory efficiency evaluation.

Clinical evaluation of total prostheses is relevant during diagnosis and evaluation of odontoiatric treatment quality. These evaluations are mainly subjective. To standardize the criteria for quality evaluation of total prostheses, Sato et al. proposed a reproducible index based on certain criteria in order to realize an objective analysis over prosthesis quality (37). This index is composed of 16 factors (Table 1).

The criteria used for total prosthesis evaluation have been established (37) through a reproducible qualitative method, which considers the analysis of seven different factors (Table 2). The

Table 1 - Reproducible index based on certain criteria in order to realize an objective analysis over prosthesis quality.

1. Does the shape and colour of anterior teeth harmonize with the patient's face?
2. Do the height and inclination of the anterior occlusal plane, and contour of lip, harmonize with the patient's face?
3. Interocclusal distance: Patient is seated in a comfortable position. He/she is instructed to relax and to bring his/her lips together lightly in an unstrained and relax manner. The distance the mandibular incisal edge moves from this position to intercuspatation is estimated with his/her lips carefully parted.
4. Fit of maxillary prosthesis: Is there pain induced by index and middle finger pressure applied equally on both sides of the first molar teeth?
5. Fit of mandibular prosthesis: Is there pain induced by index and middle finger pressure applied equally on both sides of the first molar teeth?
6. Stability of maxillary prosthesis: Is there movement induced by index and middle finger pressure on the first molar teeth? (First, a direct pressure is applied equally on both sides; then a direct pressure is applied first on one side and then on the other; and then a rotational force is applied).
7. Stability of mandibular prosthesis: Is there movement induced by index and middle finger pressure on the first molar teeth? (First, a direct pressure is applied equally on both sides; then a direct pressure is applied first on one side and then on the other; and then a rotational force is applied).
8. Tongue space: does the tongue cover the mandibular posterior teeth?
9. Occlusion: is there correct intercuspatation without premature contact or firm intermaxillary contacts in the anterior and lateral segments? Verification of occlusion (proper, simultaneous and bilateral) between maxilla and mandibula with articulating paper.
10. Articulation: Which side does display correct contact in lateral positions after gliding half the width of the premolar?
11. Retention of maxillary prosthesis: Does the denture dislodge with vertical pulling on central incisors after these are dried with gauze?
12. Retention of mandibular prosthesis: Does the denture dislodge with vertical pulling on central incisors after these are dried with gauze?
13. Extension of maxillary prosthesis:
 - Verify the prosthesis posterior limit on the level of the imaginary vibrating line (posterior seal, post-dam area), which is evident when the patient emits an A, generally 2 mm after the foveae
 - The posterior right extension correctly locates in between the maxillary tuberosity and the pterygoid process of the sphenoid
 - The poster left extension correctly locates in between the maxillary tuberosity and the pterygoid process of the sphenoid
 - The length and form of the whole flange is contoured to anatomic form.
14. Extension of mandibular prosthesis:
 - Half of the right retromolar trigone is covered
 - Half of the left retromolar trigone is covered
 - The right mylohyoid line is properly contoured to anatomic form
 - The right mylohyoid line is properly contoured to anatomic form
 - The length and form of anterior lingual flange are pertinent
 - The length and form of the whole flange is contoured to anatomic form.
15. Number of posterior teeth of the mandibular prosthesis.
16. Relation between mandibular alveolar crests and first mandibular molars is:
 - Alveolar crests on both sides are within the inner sloped plane of the buccal cusp
 - Alveolar crests on either sides is within the inner sloped plane of the buccal cusp
 - Alveolar crest on either side is lingually of lingual cusp at the first molar.

Table 2 - The criteria used for total prosthesis evaluation through a reproducible qualitative method.

1. Evaluation of frontal group. Verify that anterior teeth height and anterior occlusal plane slope harmonize with the patient's face. The height of artificial teeth has to be analysed according to the smile line, thus assuring that the cervical region of the superior central incisor corresponds with the latter line. The spelling of the letters "F" and "V" was evaluated, and eventually the patient was required to smile in order to assess the harmony of the smile curve.

Results: 1. All factors have been satisfied. 2. Only one factor has been satisfied. 3. No factor has been satisfied.

2. Interocclusal distance: the patient is seated in a comfortable position and is instructed to stay in rest position with his/her lips carefully parted. The distance the mandibular incisal edge moves from this position to intercuspation is estimated. Possible malocclusions are evaluated and classified.

Results: 1.Distance in between 1 and 4 mm. 2. Distance in between 5 and 7 mm. 3. Distance higher than 7 mm or lower than 1 mm and/or presence of possible malocclusions.

3. Stability of mandibular prosthesis: first, a manual pressure has been simultaneously applied over both premolar teeth. Then manual oblique pressure in both directions has been applied first on the right side and then on the left side.

Results: 1.The prosthesis moves in between the range of normal tissue movements (1-2 mm). 2.The prosthesis is unstable but does not move. 3. Gliding of the prosthesis has been detected.

4. Occlusion: the presence of a proper, simultaneous and bilateral intercuspation between the two arches has been verified.

Results: 1. Proper intercuspation. 2. One-sided proper intercuspation. 3. Improper intercuspation on both sides.

5. Articulation: the bilateral balance during excursion movements has been tested.

Results: 1.Both sides properly articulate. 2.Only one side properly articulates. 3. Unbalanced occlusion.

6. Retention of mandibular prosthesis: verified if the prosthesis moves thanks to vertical pulling on central incisors after these are dried with gauze.

Results: 1. Prosthesis movement without removal. 2. Difficult removal. 3. Easy removal.

7. Extension of mandibular prosthesis: the presence of the following characteristics has been verified: 1.Half of the right retromolar trigone is covered. 2.Half of the left retromolar trigone is covered. 3.The right mylohyoid line is properly contoured to anatomic form. 4.The right mylohyoid line is properly contoured to anatomic form. 5.The length and form of anterior lingual flange are pertinent. 6.The length and form of the whole flange is contoured to anatomic form.

Results: 1. All criteria have been satisfied. 2.From 1 to 5 criteria satisfied. 3. No criteria satisfied.

method allows us to evaluate prosthesis quality in a scale from 0, which comprehends all values of category 3 (low), to 100, which comprehends all values of category 1 (optimum), as reported in Table 3.

Three out of seven significant factors were regarded to be closely related to the mandibular denture. The remaining four factors are associated to both mandibular and maxillary prosthesis (37).

When evaluating masticatory function, the terms ability and efficiency have to be distinguished. The term masticatory ability refers to the subjective evaluation of patient's masticatory function, which is carried out through interviews or spe-

cific questionnaires: in this study, we used a questionnaire in which food was classified into 5 different categories according to the masticatory difficulty level (Table 4) (40).

Masticatory efficiency is defined as "the effort required to achieve a standard degree of comminution of food" (1); to evaluate it, different methods have been employed: the majority of efficiency and masticatory performance tests evaluates food particles distribution after a determined number of masticatory cycles. Some studies used a bicolour chewing gum to measure quantitatively masticatory performances. The "colour mixing test" of bicolour chewing gum used in this study is an economical, easy and reliable test; on the contrary of food tests, chewing

Table 3 - The method used to evaluate prosthesis quality in a scale from 0 to 100.

	1.excellent	2.average	3.low
1. Anterior teeth arrangement	13	2	0
2. Interocclusal distance	12	1	0
3. Stability of mandibular prosthesis	12	8	0
4. Occlusion	14	13	0
5. Articulation	16	8	0
6. Retention of mandibular denture	15	11	0
7. Extension of mandibular prosthesis	18	8	0
Total	100	51	0

Table 4 - The evaluation of masticatory ability through a questionnaire in which food was classified into 5 different categories according to the masticatory difficulty level.

Grade 1: difficulty of the patient in chewing soft consistency foods: banana, boiled carrot, boiled cauliflowers, onions

Grade 2: strawberries, ham, boiled chicken

Grade 3: difficulty of the patient in chewing medium consistency foods: apple, boiled beef, baked chicken

Grade 4: pork outlet, roasted pork, peanuts

Grade 5: difficulty of the patient in chewing hard consistency foods: raw carrots, cuttlefishes, polyps

gum mastication does not produce small food pieces, which in turn could adhere to the prosthesis or could be swallowed with consequent analysis alteration. The tests were carried out by observing colour variation. Furthermore, a colour scale has been defined so that the examiner can easily judge the colour variation level of chewed bolus without specific digital elaboration methods. However, the test has some side effects: the chewing gum could stick to prostheses surfaces, could be unpleasant for some patients and could be discouraged in diabetic patients due to the gum's sugary consistency.

Light blue and pink Hubba-Bubba Tape Gums® sample chewing gums have been used to perform the test. 30-mm portion of both colours have been realized and then coupled so that the

strip test obtained would measure 30 x 18 x 3 mm (Figure 1).

Patients were required to swallow 5 chewing gum for each test for 5, 10, 20, 30 and 50 masticatory cycles. In between different masticatory cycles, one-minute interval was observed to reduce the muscular fatigue determined by continuous mastication. Bolus shape and colour mixing level indicate masticatory efficiency.

A standardized graphic evaluation system has been utilized and subdivided into 5 categories:

1. Chewing gum did not mix, that means light blue and pink are still divided after swallowing. Cusps signs are present.
2. The majority of the chewing gum did not mix.
3. Bolus is slightly mixed but the colours are still distinguishable.

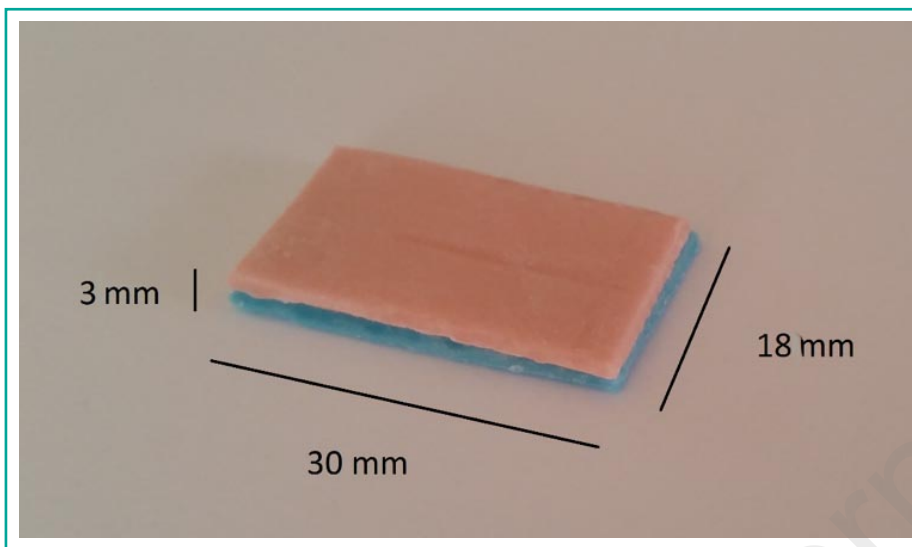


Figure 1
Light blue and pink chewing gum sample, Hubba-Bubba Tape Gums®. The test stripe measures 30 x 18 x 3 millimetres.

4. Bolus has been mixed but the colour is not uniform.
5. Bolus has been perfectly mixed with uniform colour.

A variation of the colour has taken place following the masticatory grade and the number of masticatory cycles.

- Grade 1: gum not chewed.
- Grade 2 and 3: high difficulty also in chewing regardless of food being average consistency.
- Grade 4 and 5: excellent masticatory efficiency. The number of masticatory cycles chosen for the test-alias 5, 10, 30, 30 and 50-cover the entire possible masticatory efficiency range, from highly compromised to perfectly functional. A 20-cycle mastication is sufficient to differentiate physiologic masticatory efficiency in a young subject, possessing good health and all dental elements, from an edentulous subject with substantial masticatory deficit. It has been proven that the bolus graphic evaluation system with standardized colorimetric scale is as reliable as a quantitative evaluation realized through scanning and colorimetric analysis systems with computerized programs. The bicolour chewing gum test for masticatory efficiency evaluation is more appropriate than evaluation of maximum masticatory strength alone (41).

Results

The prosthesis' qualitative values detected through State criteria have been subdivided into categories based on prosthesis' creation/utilization age (Table 5).

Discussion

Edentulism limits quality of life for majority of elderly people. Total mobile prostheses allow restoration of fundamental functions such as nutrition and language. Various studies show how carriers of removable conventional prosthesis experience a significant reduction of masticatory efficiency in comparison to individuals with complete or partial dentition; this can be associated to different factors such as loss of periodontal receptors and movement alterations (42). The maximum available masticatory force decreases over a lifetime. The capacity of prosthesis carriers to swallow trial foods is really limited if compared to subjects possessing natural dentition. Prosthesis carrier need 4/6/8 times the number of masticatory cycles compared to individuals with natural dentition. Longer chew-

Table 5 - The prosthesis' qualitative values detected through State criteria have been subdivided into categories based on prosthesis' creation/utilization age.

- Category 1: 2 prosthesis aged less than 5 years with detected value 80
- Category 2: 2 prosthesis aged from 10 to 5 years with detected value 70
- Category 3: 6 prosthesis aged from 10 to 20 years with average detected values 39
- Category 4: 2 prosthesis aged more than 20 years with detected value 30

ing and bigger food portions, compensate for scarce masticatory performances.

Masticatory efficiency of prosthesis carriers reduces to between 1/3 to 1/6 from normal values, having a critical impact over patient's quality of life regarding oral health. About one third of elderly population presents malnutrition and other conditions such as dysphagia and xerostomia, which often worsen masticatory capacity.

Not all prosthetic rehabilitations display the same qualitative standards. The goal of this study is to evaluate prosthesis quality and masticatory efficiency in total mobile prosthesis carriers. 12 patients who were supplied with total mobile prosthesis have been evaluated through artificial colorimetric bicolour chewing gum test for masticatory efficiency, through prosthesis quality evaluation (37) and through a subjective questionnaire regarding patient's masticatory ability. These surveys have been carried out while taking into consideration the year of prosthesis creation and its utilization-related age. The colorimetric test shows that the analysed masticatory efficiency is associated with both prosthesis' quality and age. A prosthesis aged less than 5 years displays high masticatory efficiency. The latter tends towards noticeable reduction for prosthesis aged between 10 and 20 years, until it appears extremely reduced in prosthesis aged more than 20 years however without compromising the patient nourishing ability. Nevertheless, these evaluations remain limited since various additional factors must be analysed to evaluate masticatory efficiency; these factors depend on the same patient, since age, sex, presence of systemic pathologies that can

alter supporting tissues and masticatory strength are all considered.

Most patients displays edentulism conditions that have been going on for several years hence leading to increased adaptation towards masticatory obstacles and a global satisfaction level also over low-qualitative standards prostheses (Figures 2, 3).

In response to the question "is there any food that you consider difficult to eat?" only few patients thought about foods already removed from their alimentary habits. Therefore, it is fundamental to ask whether the patient has difficulties in chewing specific foods, in this way the majority of patients (69%) will state masticatory difficulty with at least one food: 45% of them answered meat.

This explain why in half of the cases the patient will be inclined to remove from his/her diet those foods he/she cannot chew, and the other half of cases he/she is inclined to diversify consistency and dimensions of those troubling foods. The data obtained about the prosthesis' quality are based on subjective evaluation through a questionnaire, which is influenced by the adaptation of the patient's alimentary habits over time; the questionnaire consisted in asking the patient about the difficulty level in chewing food of low, medium or hard consistency. Patients tend to substitute aliments they cannot chew/ingest with another aliment. Therefore, evaluation of prosthesis quality and masticatory efficiency through questionnaire appears scarcely reliable.

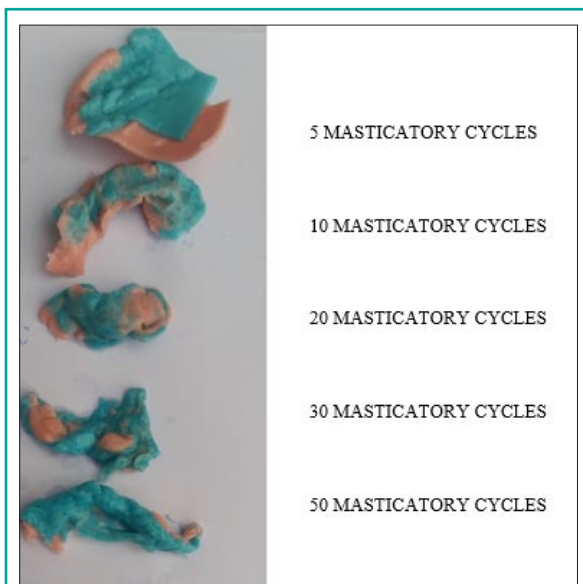


Figure 2
Prosthesis realised in 1978. Detected quality 30/100. The patient refers to be able to chew soft and medium consistency food, with noticeable limitation towards hard consistency foods. After 5 masticatory cycles grade 2 is observed. After 10 masticatory cycles grade 2 is observed. After 20 masticatory cycles grade 3 is observed. After 30 masticatory cycles grade 3 is observed and after 50 masticatory cycles grade 4 is observed. Significant masticatory efficiency reduction: association between prosthesis age and efficiency reduction.



Figure 3
Prosthesis realised in 2008. Detected quality 70/100. The patient refers to be able to chew soft and medium consistency food, with limitation towards hard consistency foods. After 5 masticatory cycles grade 3 is observed. After 10 masticatory cycles grade 4 is observed. After 20 masticatory cycles grade 4 is observed. After 30 masticatory cycles grade 5 is observed and after 50 masticatory cycles grade 5 is observed.

Conclusions

The form, which has been realised following the 7 State evaluation criteria, provides a simple, objective and reproducible quality evaluation method for total mobile prosthesis.

We found a direct connection between prosthesis quality, prosthesis age and masticatory efficiency. The subjective evaluation questionnaires gave a general idea about patient's masticatory ability, although it is biased towards the adaptation level of each patient. Our study has emphasised a correlation in the relationship between the prosthesis' quality and its age-related usage, showing a decrease in the total mobile prosthesis' quality accompanied by its increased age-related usage. In particular, the quality is noticeably reduced after 10 years, which can be considered the average life of a prosthetic artefact if

exposed to periodic check-ups and maintenance. Hopefully in the near future, both quality evaluation criteria of total mobile prosthesis and the test to determine their masticatory efficiency will be effectively and broadly used in an objective manner, with the goal of improving prosthesis performances.

References

1. Academy of Prosthodontics: Glossary of prosthodontic terms. *J Prosthet Dent.* 2005;94:10-92.
2. Petersen PE, Kandelman D, Arpin S, Ogawa H. Global oral health of older people-call for public health action. *Community Dent Health.* 2010 Dec;27(4 Suppl 2):257-67.
3. Millar WJ, Locker D. Smoking and oral health status. *J Can Dent Assoc.* 2007;73(2):155.
4. Tallgren A, Tryde G. Relationships between facial morphology and activity of orofacial muscles in patients with a complete upper and a partial lower denture. *J*

- Oral Rehabil. 1995;22(8):643-51.
5. Felton DA. Edentulism and comorbid factors. *J Prosthodont.* 2009;18(2):88-96.
 6. Carlsson GE, Omar R. The future of complete dentures in oral rehabilitation. A critical review. *J Oral Rehabil.* 2010;37(2):43-56.
 7. Enlow DH, Bianco HJ, Eklund S. The remodeling of the edentulous mandible. *J Prosthet Dent.* 1976;36(6):685-93.
 8. Corsalini M, Rapone B, Grassi FR, Di Venere D. A study on oral rehabilitation in stroke patients: analysis of a group of 33 patients. *Gerodontology.* 2010 Sep;27(3):178-82. doi: 10.1111/j.1741-2358.2009.00322.x.
 9. Corsalini M, Carella M, Boccaccio A, Lamberti L, Pappalettere C, Catapano S, Carossa S. An alternative approach to the polishing technique for acrylic resin surfaces. *Int J Prosthodont.* 2008;21(5):409-12.
 10. Notaro V, Rapone B, Cagnetta G, Sportelli P, Nardi GM, Corsalini M. Resonance frequency evaluation on immediate loading implants with angled abutments: case series. *Annali di Stomatologia.* 2018 May-August;9(2):91-96. doi: 10.11138/ads/2018.9.2.091.
 11. Di Comite M, Crincoli V, Fatone L, Ballini A, Mori G, Rapone B, Boccaccio A, Pappalettere C, Grassi FR, Favia A. Quantitative analysis of defects at the dentin-post space in endodontically treated teeth. *Materials.* 2015;8:3268-3283. Published online 2015 Jun 4. doi: 10.3390/ma8063268.
 12. Corsalini M, Di Venere D, Rapone B, Stefanachi G, Laforgia A, Pettini F. Evidence of signs and symptoms of Craniomandibular Disorders in Fibromyalgia patients. *The Open Dent Journal.* 2017;11:91-98. Published online 2017 Feb 14. doi: 10.2174/1874210601711010091.
 13. Rapone B, Nardi GM, Di Venere D, Pettini F, Grassi FR, Corsalini M. Oral hygiene in patients with oral cancer undergoing chemotherapy and/or radiotherapy after prosthesis rehabilitation: protocol proposal. *Oral Implantology.* 2016 Dic;9 (01 suppl):90-97. doi: 10.11138/orl/2016.9.1S.090.
 14. Di Venere D, Pettini F, Nardi GM, Laforgia A, Stefanachi G, Notaro V, Rapone B, Grassi FR, Corsalini M. Correlation between parodontal indexes and orthodontic retainers: prospective study in a group of 16 patients. *Oral Implantology.* 2017 Apr 10;10(1):78-86. doi: 10.11138/orl/2017.10.1.078. eCollection 2017 Jan-Mar.
 15. Grassi FR, Rapone B, Scarano Catanzaro F, Corsalini M, Kalemaj Z. Effectiveness of computer-assisted anesthetic delivery system (STA™) in dental implant surgery: a prospective study. *Oral Implantology.* 2017;10(4):381-389. ISSN:1974-5648. doi: 10.11138/orl/2017.10.4.381.
 16. Kalemaj Z, Scarano A, Valbonetti L, Rapone B, Grassi FR. Bone response to four dental implants with different surface topography: a histologic and histometric study in minipigs. *Int J Periodontics Restorative Dent.* 2016 Sep-Oct;36(5):745-54. doi: 10.11607/prd.2719.
 17. Mori G, Ballini A, Carbone C, Oranger A, Brunetti G, Di Benedetto A, Rapone B, Cantore S, Di Comite M, Colucci S, Grano M, Grassi FR. Osteogenic differentiation of dental follicle stem cells. *International Journal of Medical Sciences.* 2012;9(6):480-7. Published online 2012 Aug 13. doi: 10.7150/ijms.4583.
 18. Ballini A, Cantore S, Fatone L, Montenegro V, De Vito D, Pettini F, Crincoli V, Antelmi A, Romita P, Rapone B, Miniello G, Perillo L, Grassi FR, Foti C. Transmission of non-viral sexually transmitted infections and oral sex. *Journal of Sexual Medicine.* 2012 Feb;9(2):372-84. doi: 10.1111/j.1743-6109.2011.02515.x. Epub 2011 Oct 24.
 19. Quaglia E, Moscufo L, Corsalini M, Coscia D, Sportelli P, Cantatore F, De Rinaldis C, Rapone B, Carossa M, Carossa S. Polyamide vs silk sutures in the healing of postextraction sockets: a split mouth study. *Oral Implantology.* 2018;11(2):115-120.
 20. Pettini F, Savino M, Corsalini M, Cantore S, Ballini A. Cytogenetic genotoxic investigation in peripheral blood lymphocytes of subjects with dental composite restorative filling materials. *J Biol Regul Homeost Agents.* 2015;29(1):229-33.
 21. Di Venere D, Corsalini M, Stefanachi G, Tafuri S, De Tommaso M, Cervinara F, Re A, Pettini F. Quality of life in fibromyalgia patients with craniomandibular disorders. *Open Dent J.* 2015 Jan 30;9:9-14.
 22. Autieri G, Mussano F, Petrucci M, Carossa M, Genova T, Corsalini M, Carossa S. Proanthocyanidin may improve the shear bond strength at the composites/dentine interface. *J Biol Regul Homeost Agents.* 2018;32(4):1021-25.
 23. Mussano F, Genova T, Corsalini M, Schierano G, Pettini F, Di Venere D, Carossa S. Cytokine, Chemokine, and Growth Factor Profile Characterization of Undifferentiated and Osteoinduced Human Adipose-Derived Stem Cells. *Stem Cells Int.* 2017;2017:6202783. doi: 10.1155/2017/6202783.
 24. Laforgia A, Corsalini M, Stefanachi G, Pettini F, Di Venere D. Assessment of Psychopathologic Traits in a Group of Patients with Adult Chronic Periodontitis: Study on 108 Cases and Analysis of Compliance during and after Periodontal Treatment. *Int J Med Sci.* 2015 Oct 4;12(10):832-9.
 25. Favia G, Corsalini M, Di Venere D, Pettini F, Favia G, Capodiferro S, Maiorano E. Immunohistochemical evaluation of neuroreceptors in healthy and pathological temporo-mandibular joint. *Int J Med Sci.* 2013;10(12):1698-701.
 26. de Tommaso M, Lavalpe V, Di Venere D, Corsalini M, Vecchio E, Favia G, Sardaro M, Livrea P, Nolano M. A case of unilateral burning mouth syndrome of neuropathic origin. *Headache.* 2011 Mar;51(3):441-3.
 27. Solarino B, Coppola F, Di Vella G, Corsalini M, Quaranta N. Vestibular evoked myogenic potentials

- (VEMPs) in whiplash injury: a prospective study. *Acta Otolaryngol.* 2009;129(9):976-81.
28. Grassi FR, Pappalettere C, Di Comite M, Corsalini M, Mori G, Ballini A, Crincoli V, Pettini F, Rapone B, Boccaccio A. Effect of different irrigating solutions and endodontic sealers on bond strength of the dentin-post interface with and without defects. *Int J Med Sci.* 2012;9(8):642-54. Published online 2012 Sep 24. doi: 10.7150/ijms.4998.
 29. Di Venere D, Nardi GM, Lacarbonara V, Laforgia A, Stefanachi G, Corsalini M, Grassi FR, Rapone B, Pettini F. Early mandibular canine-lateral incisor transposition: Case Report. *Oral Implantology.* 2017 April;10(2):181-189. doi: 10.11138/orl/2017.10.2.181.
 30. Di Venere D, Corsalini M, Nardi GM, Laforgia A, Grassi FR, Rapone B, Pettini F. Obstructive site localization in patients with Obstructive Sleep Apnea Syndrome: a comparison between otolaryngologic data and cephalometric values. *Oral Implantology.* 2017 Jul-Sep;10(3):295-310. Published online 2017 Nov 30. doi: 10.11138/orl/2017.10.3.295.
 31. Corsalini M, Genovese K, Lamberti L, Pappalettere C, Carella M, Carossa S. A laboratory comparison of individual Targis/Vectris posts with standard fiberglass posts. *Int J Prosthodont.* 2007;20(2):190-2.
 32. Scivetti M, Pilolli GP, Corsalini M, Lucchese A, Favia G. Confocal laser scanning microscopy of human cementocytes: analysis of three-dimensional image reconstruction. *Ann Anat.* 2007;189(2):169-74
 33. Laforgia A, Corsalini M, Stefanachi G, Tafuri S, Ballini A, Pettini F, Di Venere D. Non-surgical periodontal management in scleroderma disease patients. *J Biol Regul Homeost Agents.* 2016;30(3):847-851.
 34. Meurman JH. Dental Infections and general health. *Quintessence Int.* 1997;28:807-11.
 35. Yeh CK, Johnson DA, Dodds MW, Sakai S, Rugh JD, Hatch JP. Association of salivary flow rates with maximal bite force. *J Dent Res.* 2000;79(8):1560-5.
 36. Fontijn-Tekamp FA, Slagter AP, Van Der Bilt A, Van 'T Hof MA, Witter DJ, Kalk W, Jansen JA. Biting and chewing in overdentures, full dentures, and natural dentitions. *J Dent Res.* 2000;79(7):1519-24.
 37. Sato Y. A method for quantifying complete denture quality. *J Prosthet Dent.* 1998;80:52-57.
 38. Yoshizumi DT. An evaluation of factors pertinent to the success of complete denture service. *J Prosthet Dent.* 1964.
 39. Pendleton EC. Changes in the denture supporting tissues. *JADA.* 1951;42:1-15.
 40. Millwood J, Heath MR. Food choice by older people: the use of semi-structured interviews with open and closed questions. *Gerodontology.* 2000;17(1):25-32.
 41. Schimmel M. A two-colour chewing gum test for masticatory efficiency: development of different assessment methods *J Oral Rehabilitation.* 2007;34:671-678.
 42. van der Bilt A. Assessment of mastication with implications for oral rehabilitation: a review. *J Oral Rehabil.* 2011;38(10):754-80.

Correspondence to:

Biagio Rapone

Department of Basic Medical Sciences, Neurosciences and Sense Organs

"Aldo Moro" University of Bari

Piazza Giulio Cesare 10

70121 Bari, Italy

E-mail: biagiorapone79@gmail.com