Aesthetics in Removable Partial Dentures: Modification of the Proximal Plate and Retentive Lamellae in Kennedy's Second Classes

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Article

Aesthetics in Removable Partial Dentures: Modification of the Proximal Plate and Retentive Lamellae in Kennedy's Second Classes

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Abstract: The removable partial denture, despite new technologies and new materials, continues to play a significant role in clinical dental practice. The purpose of the following study was to evaluate the design of new retention devices in Kennedy's second grade classrooms. For the study of "lamellar" retentive devices, 4 prosthetists were chosen and selected, according to inclusion and exclusion criteria, 16 patients, 8 women and 8 men, whose upper arch had to be rehabilitated with a removable partial prosthesis. The results showed that the parameters taken into consideration such as satisfaction, stability, aesthetics and retention had an average score higher than 3.30 (range 1-4), with an average standard deviation of 0.6225 in the 4 indicative parameters that the data they are relatively homogeneous and coherent. In conclusion we can state that the skeletonized prosthesis with lamellar retentions, designed in Kennedy's second grade classes, has shown good acceptance in selected patients

Keywords: removable prosthesis; prosthesis modification; aesthetics; retention

1. Introduction

Despite the constant evolution of digital technologies and the extensive development of implant techniques in dentistry, the removable partial denture (PPD) continues to play a significant role in clinical practice. This type of prosthesis, which has deep historical roots in the field of dental prosthetics, remains a valuable and versatile treatment option for patients with partial edentulism or missing multiple teeth. Its usefulness is supported by a series of advantages ranging from the preservation of residual dental tissue to aesthetic and functional customization [1, 2, 3]. While the dental landscape has witnessed notable advancements in digital technologies and the widespread use of dental implants to restore edentulous spaces, removable partial dentures continue to meet specific clinical needs for patients who may not be adequately rehabilitated with other solutions. Their removable nature allows for flexible management of ever-changing oral conditions, making corrections and modifications easier when needed. Furthermore, removable partial dentures offer a less invasive alternative to implant procedures, making them particularly appropriate for patients who may not be ideal candidates for dental implants. The versatility of removable partial dentures is also manifested in their ability to be adapted to patients' individual preferences and needs. Thanks to modern computer-aided design (CAD) and computer-aided manufacturing (CAM) techniques, it is possible to create highly customized and comfortable removable partial dentures, which integrate harmoniously with the oral morphology and improve the patient's aesthetics [4 , 5 , 6 , 7 , 8]. The correct insertion of the skeletonized prosthesis and periodontal health ensure that these prostheses have a long life if carefully maintained; in other cases the presence of destructive cavities, large reconstructed teeth and periodontally compromised teeth lead the patient to undergo dental extractions with consequent modification of the prosthesis and in some cases also the movement of the hook to another tooth, increasing the blemish even further [9 , 10, 11]. This research has focused attention on a new design which involves the modification of the proximal plate through the addition

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of two functionally equivalent extensions to the hooks, with the aim of giving greater retention to the proximal plate while also increasing the aesthetics of the skeletonized prosthesis [12 , 13]. The new design used mainly in the third Kennedy classes in our experimentation was used in the second Kennedy classes evaluating the efficiency, aesthetics and retention of the prosthesis.

2. Materials and Methods

For the evaluation of removable partial dentures with lamellar retentions in the second classes of Kenney, 4 freelance dentists in the Lombardy hinterland were selected, who gave their availability while respecting anonymity, to mainly carry out the branch of dental prosthetics, and at each dentist was asked to: a) select 4 patients, 2 men and 2 women; b) to create removable partial dentures in Kennedy class II edentulous cases for the upper arch with the new design where possible; c) to anonymously fill out (respecting privacy) 4 questionnaires, the first upon delivery of the prosthesis (questionnaire 1), the second after 1 month, the third at 6 months and the fourth at 12 months from delivery (questionnaire 2, 3,4). In total, a sample of 16 patients was selected, aged between 65 and 85 (patients considered elderly) who should have performed rehabilitation in the upper arch with a removable partial prosthesis. All the selected patients were not willing to undergo implant-prosthetic rehabilitation or rehabilitation with a fixed prosthesis, all the patients chose mobile rehabilitation both for economic and anatomical reasons (lack of bone). All selected patients signed the informed consent. The choice of only the upper arch for the evaluation of the parameters is mainly due to aesthetic reasons, as the more visible upper arch affects people's smiles during social relationships [14, 15, 16, 17]. Each dentist selected the patients, 2 men and two women, according to inclusion and exclusion criteria.

The inclusion criteria were:

- presence of partial edentulism classifiable as Kennedy class II;
- absence of tori that could affect the adaptability of the prosthesis;
- non-inclined residual elements (excessive undercut);
- absence of para-functions;
- presence of stable soft tissues not affected by periodontal disease or mucogingival lesions;
- adequate depth of the roots of the abutment teeth;
- informed consent of the patient and acceptance of the therapeutic rehabilitation plan with partial removable prosthesis and compliance with the dentist's instructions.
- age between 65 and 85 years.

Patients who met the following exclusion criteria were excluded from the study:

- poor oral hygiene and lack of patient compliance;
- smoking habits (>10 cigarettes/day);
- subjects suffering from oral pathologies;
- active periodontal disease;
- anomalies in the anatomy of the labial frenulum (which can interfere with the insertion and adaptability of the removable prosthesis);
- drug addictions;
- psychiatric pathologies;
- subjects disbarred less than 5 years ago;
- subjects on bisphosphonate therapy;
- deep bite;
- failure to consent to prosthetic rehabilitation and to comply with the dentist's instructions.

The selected patients were numbered from 1 to 16 in order to respect anonymity and privacy (Table 1).

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Table 1. Sample of selected patients.

Dentist 1	Age	Sex	Abutment teeth
1	66	M	14, 11, 21, 22, 23, 27
2	68	M	17, 16, 13, 12, 11, 21, 22, 23, 24
3	67	W	15, 14, 13, 11, 21, 22, 23, 27
4	76	W	14, 13, 11, 21, 22, 23, 26, 27
Dentist 2			
5	69	W	17, 14, 13, 11, 21, 22, 24
6	72	W	15, 13, 12, 11, 21, 23, 27
7	74	M	14, 11, 21, 22, 23, 27
8	72	M	17, 14, 13, 11, 21, 22, 23, 24
Dentist 3			
9	71	W	15, 14, 23, 24, 27
10	76	W	15, 14, 11, 21, 23, 24, 27
11	68	M	15, 13, 12, 11, 21, 23, 27
12	67	M	13, 12, 11, 21, 22, 23, 27
Dentist 4			
13	70	W	14, 13, 11, 21, 23, 27
14	73	W	17, 13, 12, 11, 21, 22, 23, 24, 25
15	76	M	14, 13, 12, 22, 23, 26, 27
16	82	M	14, 13, 12, 11, 22, 23, 24, 27

Questionnaire n. 1 administered to patients upon delivery of the prosthesis

Date…… Evaluation from patient n°_____

Generality

Se Man ☐ Woman ☐

Date of application of the prosthesis .....……..

Subjective judgment of the patient (part to be filled upon delivery)

Satisfactory aesthetics Yes ☐ NO ☐

Satisfactory occlusion Yes ☐ NO ☐

Satisfacrory adhesion Yes ☐ NO ☐

Satisfactory retention Yes ☐ NO ☐

I declare that I comply with the following controls:

1st inspection 1 month after delivery Yes ☐ **NO** ☐

2st inspection 6 month after delivery Yes ☐ NO ☐

3st inspection 12 month after delivery Yes ☐ NO ☐

Questionnaire administered to patients 1, 6, 12 months after delivery of the prosthesis

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Date..... Patient Evaluation Form **N°**_____

Generality

Se Man ☐ Woman ☐

Date of application of the prosthesis .....……..

Evaluation of the prosthesis inserted into the oral cavity On a scale from 1 to 4 (where 1 is insufficient and 4 is excellent) what score do you give to the prosthesis you are wearing:

Satisfaction	1	2	3	4
Stability	1	2	3	4
Esthetics	1	2	3	4
Retention	1	2	3	4

Evaluation of the prosthesis not inserted in the oral cavity

Denture Hygiene: clean ☐ rtar deposits pi☐entations ☐

Use of the adhesive : Yes ☐ NO ☐

The prosthesis broke: Yes ☐ NO ☐

The prosthesis has been repaired: Yes ☐ NO ☐

All dentists were asked to speak with the dental technician for the design of the retentions and the proximal plate in order to have adequate retention and aesthetics. The dental technician was provided with a drawing and wax-up of the project in the study model in order to replicate the same with the removable partial denture (Figure 1 a-d).

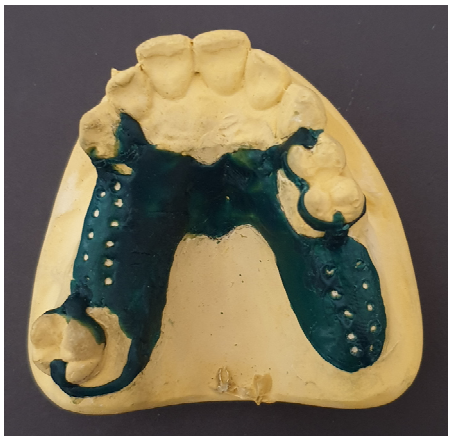

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Figure 1. a-b. a) Drawing on study model - patient n° 14 -; b) same study model with the wax applied for greater vision to the dental technician; c) absence of visible hooks; d) lamellar retentions on the proximal plate.

3. Results

The results are based on the information obtained from the questionnaires filled out at each check-up by the patients taken as a sample considering a follow-up period of 12 months (Tables 2, 3 and 4), Table 5 expresses the reference values. Some aspects such as satisfaction, stability, retention and aesthetics were taken into consideration. The results were evaluated by averaging the values to have an immediacy of any critical issues, while for the last questionnaire the standard deviation was also calculated to evaluate any differences in the values of each observation compared to the average after 12 months. of the variables.

Table 2. Results of questionnaire 1 administered 1 month after delivery. Evaluation with arithmetic mean of the results.

Patient	Satisfaction	Stability	Retention	Aethetics	**Overall ratyng**
1	4	3	4	4	3,75
2	4	4	4	4	4
3	3	3	4	4	3,5
4	3	4	3	4	3,5
5	3	4	4	4	3,75
6	4	4	4	4	4
7	4	4	4	4	4
8	3	3	3	3	3
9	3	4	4	4	3,75
10	4	4	4	4	4
11	4	4	4	3	3,75
12	4	4	3	3	3,5
13	2	3	2	2	**2,25**
14	3	4	3	4	3,5
15	2	3	3	3	2,75
16	3	3	3	3	3
Media	3,31	3,63	3,50	3,56	3,50

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Table 3. Results of questionnaire 2 administered 6 months after delivery. Evaluation with arithmetic mean of the results.

Patient	Satisfaction	Stability	Retention	Aesthetics	Overall ratyng
1	4	3	4	4	3,75
2	4	4	4	4	4
3	3	3	4	4	3,5
4	3	4	3	4	3,5
5	3	4	4	4	3,75
6	4	4	4	4	4
7	4	4	4	4	4
8	3	3	3	3	3
9	3	4	4	4	3,75
10	4	4	4	4	4
11	4	4	4	3	3,75
12	4	4	3	3	3,5
13	2	2	2	2	2
14	3	4	3	4	3,5
15	2	3	3	3	2,75
16	3	3	3	3	3
Media	3,31	3,56	3,50	3,56	3,48

Table 4. Results of questionnaire 3 administered 12 months after delivery.

Patient	Satisfaction	Stability	Retention	Aesthetics	Overall ratyng
1	4	3	4	4	3,75
2	4	4	4	4	4
3	3	3	4	4	3,5
4	3	4	3	4	3,5
5	3	4	4	4	3,75
6	4	4	4	4	4
7	4	4	4	4	4
8	3	3	3	3	3
9	3	4	4	4	3,75
10	4	4	4	4	4
11	4	4	4	3	3,75
12	4	4	3	3	3,5
13	2	2	2	2	2
14	3	4	3	4	3,5
15	2	3	3	3	2,75
16	3	3	3	3	3
Media	3,31	3,56	3,50	3,56	3,48

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σ	0,68	0,60	0,61	0,60	

Table 5. Legenda valori di riferimento.

Reference values	Satisfaction	Stability	Retention	Aesthetics
1- 2,99	Not satisfied	Not stable	He wasn't retentive	Not aesthetic
3- 3,99	Satisfied	Stable	Retentve	Aesthetics
4	Very satisfied	Stable	Very retentive	Very aesthetic

During the checks, no patient underwent treatment on the abutment teeth and no clinically evident cavities were found in any element. No patient discontinued use of the skeleton due to lack of retention or stability. At the first check-up, one month after delivery, the patient identified with number 13 expressed a low score (2 out of 4) for three parameters (retention, aesthetics and satisfaction), while the patient identified with number 15 expressed a low score for all parameters.

At the six-monthly checks only in a single case (Questionnaire 2 - patient identified with number 8) was a fracture of a resin element found. Once the element was replaced, the patient was satisfied with the result and at the subsequent check-up the skeleton was found to be perfectly suitable. Patients identified with numbers 13 and 15 expressed low scores. The last questionnaire, at 12 months, was completed by only 14 patients, the patients identified with numbers 2 and 7 did not show up for the check-up. Interviewed by telephone on the same day, using the same parameters, they reported having no problems of any kind and that they were very satisfied. For our investigation, both patients were assigned the maximum value of 4 in all sections. The patient identified with the number 13, despite the checks and attention, did not feel satisfied because he did not accept the idea of having a mobile prosthesis, the patient identified with the number 15, despite the prosthesis being stable and aesthetic, did not feel satisfied .

The two most appreciated parameters among those evaluated in the questionnaires were aesthetics and stability, obtaining a score of 3.56 out of 4. Ten patients (62.5%) expressed a score of 4 out of 4 in the aesthetics and in the stability boxes. A detail found by the dentists during the checks was that no patient requested the activation of the lamellae retentions to improve retention and only two patients identified with the numbers 9 and 5 used the adhesive paste for dentures, only on the occasions of social dinners , for fear that the prosthesis might move. Another important fact is that in no case was it necessary to reline the prosthesis after some time (12 months).

4. Discussion

Edentulism still represents a very important problem to solve for dentists today, dental caries and periodontal diseases are the main causal factors of tooth loss and, if not treated adequately, lead to edentulism [18, 19, 20, 21]. The aesthetic judgment of patients, often negative regarding the removable partial denture, is very high due to the vision of the clasps, the retention, furthermore after the delivery of the prosthesis there are subsequent adjustments or modifications to the prostheses in the following years also due to periodontal problems [22 , 23, 24]. The progress of the different techniques that use the new Cad/Cam technologies have allowed operators to use design software also using different materials to find increasingly comfortable and aesthetic solutions for the patient [25, 26, 27, 28, 29, 30, 31]. The results of this study highlight how the lamellar retentions in the edentulous areas interspersed in Kennedy's II classes had a good evaluation for the parameters examined. In these edentulous areas we tried to exploit the modification of the proximal plate by designing it a few tenths of a millimeter per below the undercut of the tooth so as to be more retentive, furthermore if we consider the forces that insist on an inclined plane we can say that the friction force during the removal of the prosthesis represents the value of the angle between the tooth and the proximal plate. From a practical point of view, the inclined plane is used to move bodies using less effort than that necessary for their vertical lifting; in prosthetic terms, the more adherent the proximal plate is, the greater the effort will be to remove the prosthesis. Of the 16 patients selected, 7 patients

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(43.75%) considered themselves very satisfied with the therapeutic choice, 7 patients (43.75%) considered themselves satisfied and only 2 patients (13.5%) did not consider themselves satisfied. Examining the standard deviation values obtained for 4 parameters 0.68 for satisfaction, 0.60 for stability, 0.61 for retention and 0.60 for aesthetics, we can say that the data are relatively homogeneous and coherent, with little significant variation between data points. This may indicate some stability or uniformity within the phenomenon or process being sampled.

In practical terms, low values of standard deviation suggest that the measurements or observations are very similar to each other and that there are few significant fluctuations. However, it is important to consider the sample size which is small. The design of the skeletonized prosthesis with lamellar retentions, in Kennedy class III edentulism, was introduced in the 2000s. In the first study of 2003 the concept of "lamellae" is described, in particular the modification of the proximal plate of the skeleton by applying two extensions having the same functions as a hook, in the year following 2004 with the collection of a sample of 31 patients with Kennedy class III partial edentulism, the stability, retention, integrity, hygiene of the prosthesis and conditions of the elements were checked teeth adjacent to the edentulous area, evaluating the presence of caries, mobility of the residual elements [12, 13]. The search for aesthetics by modifying the hooks to make them increasingly aesthetic has been an objective pursued by researchers [32, 33]. The design of the modified retentive devices are very aesthetic as they do not have a supraequatorial portion, their occlusal and lateral stability is maintained by the large secondary joint and the primary support designed distally (Figure 2). Clearly the information and indications that the dentist must provide to the technician must be as precise as possible, especially on the health of the periodontium [34, 35, 36, 37].

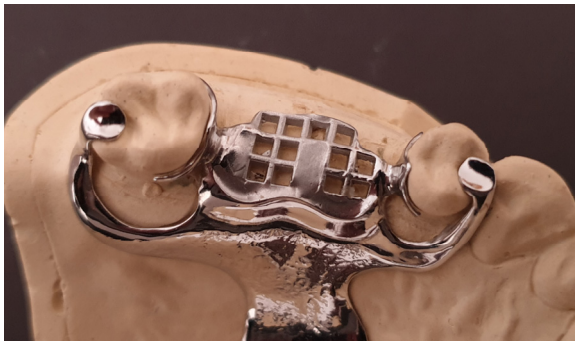

Figure 2. View of the retentive means.

In light of the results obtained in previous studies and the following study, it is demonstrated that the design of the skeletonized prosthesis with lamellar retentions is not harmful to the periodontal structures of the residual teeth if the level of oral hygiene is maintained good and professional checks are constant.

5. Conclusions

In conclusion, we can state that the lamellar retentions designed in Kennedy's second classes have shown good satisfaction in selected patients. The dialogue between the dentist and dental technician during the design of the prostheses was fundamental for the aspects of retention and aesthetics by not altering the occlusion. In light of the results obtained, we can confirm that even in non-implant-prosthetic cases, the skeletonized partial prosthesis can represent a valid solution for patients, especially if lamellar retentions are designed in the intercalated areas. This study could be continued with a longer follow-up at 2 and 3 years to also evaluate the periodontal appearance and the mobility index of the abutment teeth.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data supporting reported results of this study are available from saverio.ceraulo@unimib.it, upon reasonable request.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Elfadil S, Kahatab A, Cronin E, O'Mahony A. Chairside technique for addition of teeth to an acrylic partial denture. A clinical report. Heliyon. 2023 Jul 7;9(7):e18040. doi: 10.1016/j.heliyon.2023.e18040. PMID: 37483718; PMCID: PMC10362310.
2. Goswami M, Chauhan N. Prosthetic Management with Removable Partial Dentures in Pediatric Dental Care: Case Series. Int J Clin Pediatr Dent. 2023 May-Jun;16(3):534-540. doi: 10.5005/jp-journals-10005-2593. PMID: 37496936; PMCID: PMC10367292.
3. Goguta L, Frandes M, Candea A, Ille C, Jivanescu A. Impact of unilateral removable partial dentures versus removable partial dentures with major connector on oral health-related quality of life of elder patients: a clinical study. BMC Oral Health. 2023 Mar 29;23(1):182. doi: 10.1186/s12903-023-02870-x. PMID: 36991435; PMCID: PMC10061744.
4. Wang WR, Xie R, Niu LN, Feng ZH, Zhao YM. Novel Digital Mouth Preparation Technique for Fabricating Implant-Retained Removable Partial Dentures with Distal Extension: a Case Report. Chin J Dent Res. 2023 Jun 23;26(2):113-117. doi: 10.3290/j.cjdr.b4128029. PMID: 37395523.
5. Jayaraman S, Singh BP, Ramanathan B, Pazhaniappan Pillai M, MacDonald L, Kirubakaran R. Final-impression techniques and materials for making complete and removable partial dentures. Cochrane Database Syst Rev. 2018 Apr 4;4(4):CD012256. doi: 10.1002/14651858.CD012256.pub2. PMID: 29617037; PMCID: PMC6494560.
6. Kumari KS, K S A. An Esthetic Approach for Rehabilitation of Long-Span Edentulous Arch Using Artificial Intelligence. Cureus. 2023 May 7;15(5):e38683. doi: 10.7759/cureus.38683. PMID: 37292565; PMCID: PMC10244077.
7. Rues S, Tasaka A, Fleckenstein I, Yamashita S, Rammelsberg P, Boehm S, Schwindling FS. Fit and Retention of Cobalt-Chromium Removable Partial Denture Frameworks Fabricated with Selective Laser Melting. J Funct Biomater. 2023 Aug 8;14(8):416. doi: 10.3390/jfb14080416. PMID: 37623661; PMCID: PMC10456016.
8. Akinyamoju CA, Ogunrinde TJ, Taiwo JO, Dosumu OO. Comparison of patient satisfaction with acrylic and flexible partial dentures. Niger Postgrad Med J. 2017 Jul-Sep;24(3):143-149. doi: 10.4103/npmj.npmj_54_17. PMID: 29082902.
9. Campbell SD, Cooper L, Craddock H, Hyde TP, Nattress B, Pavitt SH, Seymour DW. Removable partial dentures: The clinical need for innovation. J Prosthet Dent. 2017 Sep;118(3):273-280. doi: 10.1016/j.prosdent.2017.01.008. Epub 2017 Mar 23. PMID: 28343666.
10. Bruna Benso, Ana C. Kovalik, Janaina H. Jorge & Nara H. Campanha (2013) Failures in the rehabilitation treatment with removable partial dentures, Acta Odontologica Scandinavica, 71:6, 1351-1355, DOI: 10.3109/00016357.2013.777780
11. Hatayama T, Chiba A, Kainose K, Nakajima M, Hosaka K, Wakabayashi N, Foxton RM, Tagami J. Stress distribution in tooth resin core build-ups with different post-end positions in alveolar bone level under two kinds of load directions. Dent Mater J. 2018 Jun 8;37(3):474-483. doi: 10.4012/dmj.2017-160. Epub 2018 Feb 8. PMID: 29415970.
12. S. Ceraulo. Ritenzione a lamella su modifica della placca prossimale. Una nuova progettazione ideata dall'autore della ricerca in riabilitazioni Protesiche parziali rimovibili scheletrate di III classe. Protech, Anno 2, n°5, pag. 21-24, Ottobre 2001.
13. S. Ceraulo**.** Follow-up a due anni della PPS con ritezioni a lamelle. Supplemento Doctor OS, Anno XV, n° 4, aprile 2004.
14. Straulino E, Scarpazza C, Spoto A, Betti S, Chozas Barrientos B, Sartori L. The Spatiotemporal Dynamics of Facial Movements Reveals the Left Side of a Posed Smile. Biology (Basel). 2023 Aug 23;12(9):1160. doi: 10.3390/biology12091160. PMID: 37759560; PMCID: PMC10525663.
15. Al-Kaisy N. Measurement of vertical anterior teeth display and lip position at smiling in Kurdish population. Age and gender-based evaluation. Heliyon. 2023 Aug 28;9(9):e19465. doi: 10.1016/j.heliyon.2023.e19465. PMID: 37809926; PMCID: PMC10558590.
16. Cheng JH, Hsu YC, Lee TY, Li RW. Factors affecting perception of laypeople and dental professionals toward different smile esthetics. J Dent Sci. 2023 Apr;18(2):739-746. doi: 10.1016/j.jds.2022.11.030. Epub 2022

Dec 13. PMID: 37021227; PMCID: PMC10068377.

17. Saffarpour A, Ghavam M, Saffarpour A, Dayani R, Fard MJ. Perception of Laypeople and Dental Professionals of Smile Esthetics. J Dent (Tehran). 2016 Mar;13(2):85-91. PMID: 27928236; PMCID: PMC5139935.
18. Al-Rafee MA. The epidemiology of edentulism and the associated factors: A literature Review. J Family Med Prim Care. 2020 Apr 30;9(4):1841-1843. doi: 10.4103/jfmpc.jfmpc_1181_19. PMID: 32670928; PMCID: PMC7346915.
19. Gabiec K, Bagińska J, Łaguna W, Rodakowska E, Kamińska I, Stachurska Z, Dubatówka M, Kondraciuk M, Kamiński KA. Factors Associated with Tooth Loss in General Population of Bialystok, Poland. Int J Environ Res Public Health. 2022 Feb 18;19(4):2369. doi: 10.3390/ijerph19042369. PMID: 35206557; PMCID: PMC8872086.
20. Shah PD, Badner VM. Association between asthma and severe tooth loss in the adult population of the United States. J Asthma. 2022 Mar;59(3):462-468. doi: 10.1080/02770903.2020.1856868. Epub 2020 Dec 24. PMID: 33356681.
21. Hasegawa K, Sakurai A, Mizuki M, Kurita H, Tsukahara T, Nomiyama T. Association between the number of teeth and incident pre-diabetes among middle-aged adults with periodontal disease: a retrospective cohort analysis of Japanese claims data. BMJ Open. 2023 Nov 19;13(11):e075527. doi: 10.1136/bmjopen-2023-075527. PMID: 37984959; PMCID: PMC10660919.
22. D'Souza NL, Hajhamid B, Somogyi-Ganss E. Postinsertion adjustment appointments and their association with cast removable partial denture survival. J Prosthet Dent. 2023 Aug;130(2):238.e1-238.e7. doi: 10.1016/j.prosdent.2023.05.003. Epub 2023 Jul 6. PMID: 37419711.
23. Cumbo, E.; Messina, P.; Gallina, G.; Scardina, G.A. An Experimental Method to Add New Prosthetic Teeth in the Removable Partial Denture Framework: TIG Cold Welding and Preformed Pins. *Prosthesis* **2023**, *5*, 1120-1128. https://doi.org/10.3390/prosthesis5040078
24. Al-Dwairi ZN, Taani DS, Naseeb AZ, Al-Haj Husain N, Özcan M, Lynch E. Evaluation of Clinical Periodontal Parameters of Abutment Teeth Supporting Distal-Extension Base Removable Partial Dentures: A Cross-sectional Study. Eur J Prosthodont Restor Dent. 2023 Jun 15. doi: 10.1922/EJPRD_2500AlDwairi09. Epub ahead of print. PMID: 37318323.
25. Tregerman I, Renne W, Kelly A, Wilson D. Evaluation of removable partial denture frameworks fabricated using 3 different techniques. J Prosthet Dent. 2019 Oct;122(4):390-395. doi: 10.1016/j.prosdent.2018.10.013. Epub 2019 Apr 1. PMID: 30948301.
26. Carneiro Pereira AL, Bezerra de Medeiros AK, de Sousa Santos K, Oliveira de Almeida É, Seabra Barbosa GA, da Fonte Porto Carreiro A. Accuracy of CAD-CAM systems for removable partial denture framework fabrication: A systematic review. J Prosthet Dent. 2021 Feb;125(2):241-248. doi: 10.1016/j.prosdent.2020.01.003. Epub 2020 Mar 5. PMID: 32147252.
27. Ahmed N, Abbasi MS, Haider S, Ahmed N, Habib SR, Altamash S, Zafar MS, Alam MK. Fit Accuracy of Removable Partial Denture Frameworks Fabricated with CAD/CAM, Rapid Prototyping, and Conventional Techniques: A Systematic Review. Biomed Res Int. 2021 Sep 6;2021:3194433. doi: 10.1155/2021/3194433. PMID: 34532499; PMCID: PMC8440078.
28. Takaichi A, Fueki K, Murakami N, Ueno T, Inamochi Y, Wada J, Arai Y, Wakabayashi N. A systematic review of digital removable partial dentures. Part II: CAD/CAM framework, artificial teeth, and denture base. J Prosthodont Res. 2022 Jan 11;66(1):53-67. doi: 10.2186/jpr.JPR_D_20_00117. Epub 2021 Jan 26. PMID: 33504722.
29. Jafarpour D, Feine JS, Morris M, Souza RF. Patient-reported outcomes and clinical performance of CAD/CAM removable dentures: A scoping review. Int J Prosthodont. 2023 Oct 12;0(0). doi: 10.11607/ijp.8556. Epub ahead of print. PMID: 37824115.
30. Ali IE, Tanikawa C, Chikai M, Ino S, Sumita Y, Wakabayashi N. Applications and performance of artificial intelligence models in removable prosthodontics: A literature review. J Prosthodont Res. 2023 Oct 5. doi: 10.2186/jpr.JPR_D_23_00073. Epub ahead of print. PMID: 37793819.
31. Iannello, G.; Fiorillo, L.; D'Amico, C.; Minervini, G.; Terranova, A.; Cervino, G. Presenting a Protocol for Dental Implant Restorations. *Prosthesis* **2023**, *5*, 1153-1170. https://doi.org/10.3390/prosthesis5040081
32. Shen X, Zhang C, Jia X, Li D, Liu T, Tian S, Wei W, Sun Y, Liao W. TranSDFNet: Transformer-Based Truncated Signed Distance Fields for the Shape Design of Removable Partial Denture Clasps. IEEE J

Biomed Health Inform. 2023 Oct;27(10):4950-4960. doi: 10.1109/JBHI.2023.3295387. Epub 2023 Oct 5. PMID: 37471183.

33. Pordeus MD, Gasparetto GD, Machado LMR, Noritomi PY, Costa RMBD, Chappuis-Chocano AP, Venante HS, Junior JFS, Porto VC. A New Proposal for Calibrated Gauges for Removable Partial Dentures: A Finite Element Analysis. J Contemp Dent Pract. 2022 Dec 1;23(12):1230-1236. doi: 10.5005/jp-journals-10024-3453. PMID: 37125521.
34. Zhang N, Mao B, Dai Y, Chen S, You Z, Zhang J, Chen X, Dong H, Yue L, Yu H. Audit to assess the quality of 916 prosthetic prescriptions of removable partial dentures. Hua Xi Kou Qiang Yi Xue Za Zhi. 2023 Jun 1;41(3):315-322. English, Chinese. doi: 10.7518/hxkq.2023.2021565. PMID: 37277798; PMCID: PMC10317851.
35. Jayaraman S, Singh BP, Ramanathan B, Pazhaniappan Pillai M, MacDonald L, Kirubakaran R. Final-impression techniques and materials for making complete and removable partial dentures. Cochrane Database Syst Rev. 2018 Apr 4;4(4):CD012256. doi: 10.1002/14651858.CD012256.pub2. PMID: 29617037; PMCID: PMC6494560.
36. Radford PJ, Walton J, McManus R. Should dental technicians play a greater role in the education of foundation dentists? Br Dent J. 2020 Nov;229(10):653-654. doi: 10.1038/s41415-020-2337-5. Epub 2020 Nov 27. PMID: 33247254.
37. Juszczyk AS, Clark RK, Radford DR. UK dental laboratory technicians' views on the efficacy and teaching of clinical-laboratory communication. Br Dent J. 2009 May 23;206(10):E21; discussion 532-3. doi: 10.1038/sj.bdj.2009.434. PMID: 19444251.