



Clinical-statistical study on oral rehabilitation methods using dental implants

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Abstract

Background and aims. The development of dental implantology is based on a thorough examination of the interaction of implants with the surrounding tissues, as well as methods of stimulating osteogenesis around implants. The most common approach to restore lost dentition in terms of function and aesthetics is now represented by implants. The objective of our study was to comparatively assess the efficiency of prosthetic treatments performed on implants alone versus on implants in conjunction with abutment teeth.

Methods. The study was carried out over seven years (2016–2023), with evaluations at one, two, three, and five years. For this analysis, MedCalc® version 12.5.0.0 (MedCalc® Software, Mariakerke, Belgium) was utilised as the medical statistical software.

Results and conclusions. When using dental implants and natural teeth abutments for prosthodontic reconstruction, the failure rates rise approximately 43 times when compared to dental implant rehabilitation; similarly, osteoporosis and diabetes mellitus increase failure rates by 32 and 20 times, respectively. Gingival inflammation is a frequent event (almost 50% frequency) observed during follow-up of patients who had prosthetic restoration using dental implants alone as well as implants and abutment teeth. For both groups, difficulties usually arise two years later.

Keywords: dental implants, prosthetic rehabilitation, bone volume reconstruction, inflammatory complications

Introduction

Oral implant rehabilitation has evolved significantly to address the challenges faced by edentulous patients. Hence, treating partially edentulous patients with implants is now the most popular way to restore lost function in terms of chewing ability and appearance. Long-term clinical studies (>5 years) show high implant and prosthetic survival rates for fixed dentures with fixed prostheses on implants emerging as a successful solution [1,2]. In the

recent years, the need for alveolar ridge reconstruction by bone addition and remodeling of bone support has been a current concern in oral implantology due to the increasing rate of edentulism in the younger population. Careful assessment of periodontal status and edentulous areas is important to ensure long-term success when considering implant-prosthetic reconstruction on both implants and abutment teeth [3–8]. Since ancient times, mankind has been grappling with tooth loss, partial or total edentulations, and their

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impact on the entire stomatognathic system. These changes impact its primary functions, leading to mastication disorders, phonation issues, and unsightly physiognomy. It is important to carefully assess the periodontal status and edentulous areas to ensure long-term success when considering implant-prosthetic reconstruction on both implants and abutment teeth [3-8]. Depending on the patients' systemic conditions, bone healing was accomplished after 6–9 months, followed by prosthetic loading [9]. Several American researchers have determined that individuals with diabetes who maintain control over their disease and maintain blood sugar levels below 160 mg/dl for the past six months qualify for dental implants [9].

This study aimed to comparatively evaluate the success of implant prosthetic treatments on implants alone, as well as on implants and abutment teeth. The specific objectives of this study were to assess the general status of the associated pathologies, as well as the dento-periodontal status of the patients studied, a comparative evaluation of the methods and modalities of bone volume reconstruction, and late inflammatory complications for the two study groups.

Methods

The sample of the study included a number of 92 respondents, patients aged between 30 and 67 years, selected by a stratified random sampling method. Strata were defined based on demographic variables such as age and gender. The target group consisted of patients treated by dental practitioners in the county of Oradea (individual dental practices or dental clinics), who needed dental implants and were willing to participate in the study after it was explained to them what this study consisted of and what it aimed to achieve.

Inclusion criteria were: patients who needed implants and accepted the treatment plan, and who gave their consent for implant insertion as well as those who gave their written consent to participate for this study.

Exclusion criteria: patients who did not give their written consent for the treatment plan regarding the insertion of implants, also patients who did not give their written consent for participation for this clinical trial. Patients were also excluded if they had not been to any dental check-up in the last 6 months, although they reside in the county and have not visited any dental office in the county.

This study is a comparative analysis of the 92 patients who received implant-prosthetic treatment. The patients were further divided into two groups: implant prosthetic reconstruction on implants alone and prosthetic reconstruction with support on both implants and teeth abutment. These patients, with an average age of 51.7 years, had 292 implants inserted. This study was conducted over a period of seven years (2016–2023), with periodic evaluations at one year, two years, three years and five years. It was used the medical statistics programme MedCalc® version 12.5.0.0 (MedCalc® Software, Mariakerke, Belgium) for

this analysis. The statistical tests results represented the probability of the “null” hypothesis (p), whose value below 0.05 indicates a statistically significant difference between the studied groups, represented the results of the statistical tests. Patients needed prosthetic treatment of maxillary and mandibular partial edentulousness, or even bilateral maxillary edentulousness, with mild, moderate, or even severe alveolar defects. An anamnesis was performed, as well as a clinical and paraclinical examination (orthopantomography, CBCT). To establish a treatment plan, following the anamnesis and evaluation of the general and dento-periodontal status of the patients, the following factors were considered: history of the current condition, general medical history and patient's dento periodontal status. The remaining teeth were evaluated in terms of crown size, crown-to-root ratio, position, and abutment tooth axis. Through imaging examinations, we determined the root configuration, the presence or absence of endodontic pathology. The bone field was assessed using both clinical and radiographic examinations. This provided details on the quantity and quality of bone. The imaging methods were: retroalveolar radiographs, orthopantomography, occlusal lateral radiographs, computed tomography (CT) and nuclear magnetic resonance (NMR) [10].

We also took into account the cause of the current bone atrophy, determining whether the patient lost teeth prematurely and whether he was edentulous for a long period of time, resulting in severe bone atrophy. We examined whether the removal of a tumor or pathological lesion caused the missing teeth and bone or if trauma was the cause. Also, until recently, diabetes was an absolute contraindication to the insertion of dental implants. After checking the patients' overall health, the condition of their teeth and gums, the amount of bone needed for implants, and bone regeneration methods with different additive materials, surgical approaches that were specific to the jaw's loco-regional structure in areas where there wasn't enough bone were used. This stage also included implant insertion.

Results

Patients were divided into 2 groups according to the mode of reconstruction: dental implant reconstruction only (Group I - 47 patients 51.1%) and dental implant and natural teeth abutment reconstruction (Group II - 45 patients 48.9%).

Patients in the study group with dental implant and natural abutment rehabilitation were significantly younger than patients with implant-supported rehabilitation. However, gender and environment did not differ significantly. As an associated pathology, only arterial hypertension was significantly more frequent in group I patients (derived from older age). The most common cause of edentulism remains inflammatory periodontal lesions, followed by poor oral hygiene and other oro-gingival mucosal diseases (Table I). Patients with dental implant-only reconstruction exhibit a much more pronounced decrease in bone supply (Figure 1).

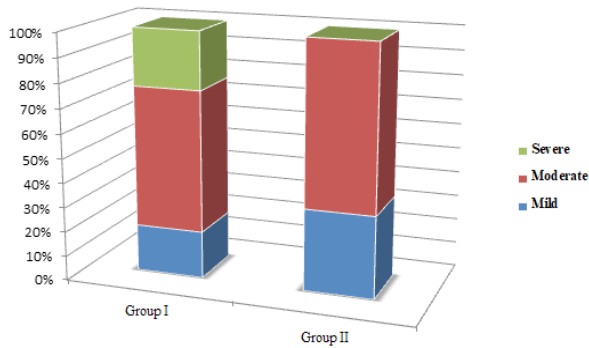


Figure 1. Severity of decreased bone supply for patients in the two study groups.

The methods of reconstruction of the bone volume necessary to insert implants had a similar distribution for the two methods of reconstruction (according to table II and figure 2).

The duration of osseointegration was similar in both groups, with the majority taking 9 months. The number of implants was obviously higher in the implant-only cases,

but the method of bone volume reconstruction had a similar distribution for the two reconstruction modalities (Table II).

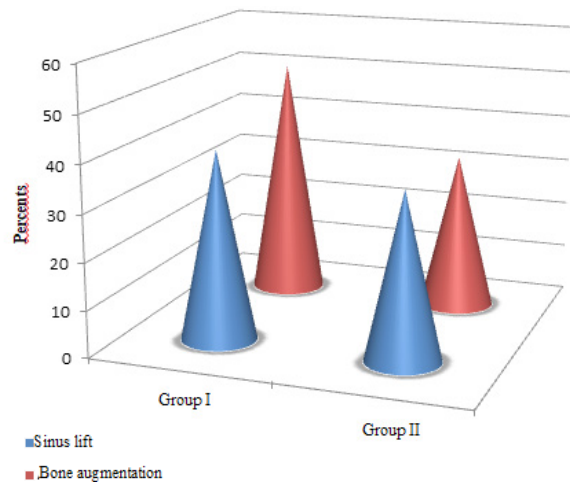


Figure 2. Percentages of bone volume reconstruction methods for the two study groups.

Data related to the immediate postoperative outcome of patients in the two study groups are described in table III.

Table I. Baseline demographic and clinical characteristics for patients in the two study groups.

	Group I (n=47)	Group II (n=45)	Statistical significance (p)
Age – median (IQR)	49 (41.3-57.8)	44 (38-51)	0.0109*
Sex (M/F)	30/17	20/25	0.0976**
Environment (U/R)	38/9	30/15	0.1897**
<i>Associated pathology - no. of patients (%)</i>			
Diabetes mellitus	12 (25.5)	5 (11.1)	0.1303**
High blood pressure	35 (74.5)	23 (48.9)	0.0354**
Chronic ischemic heart disease	11 (23.4)	6 (13.3)	0.3293**
Smoking	15 (31.9)	21 (46.7)	0.2166**
Ethylism	2 (4.3)	1 (2.2)	0.9695**
Osteoporosis	5 (10.6)	4 (8.9)	0.9452**
<i>Cause of edentulism - no. patients (%)</i>			
Parodontitis	40 (85.1)	39 (86.7)	0.9326**
Poor oral hygiene	6 (12.8)	8 (17.8)	0.7049**
Diseases of the oral mucosa	6 (12.8)	3 (6.7)	0.5265**
Decreased bone supply (Mild / Moderate / Severe)	9/27/11	15/30/0	0.0018***

* - testul Mann-Whitney test; ** - chi-square test with Yates' correction; *** simple chi-square test; IQR = interquartile range

Table II. Methods of bone volume reconstruction in the patients of the two groups.

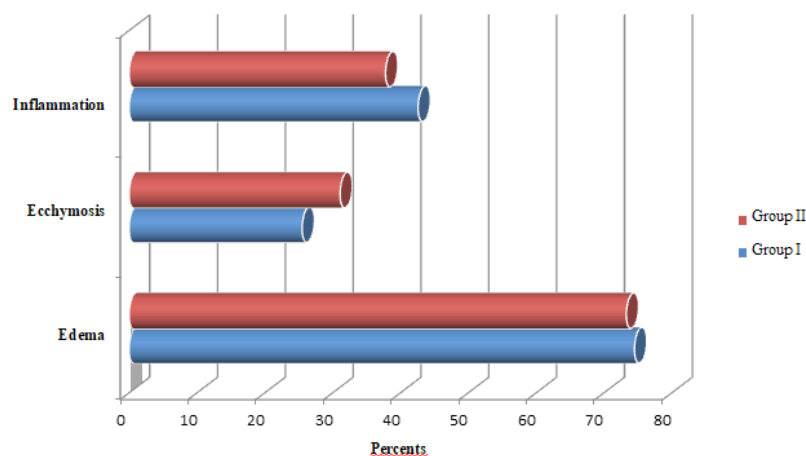
	Group I (n=47)	Group II (n=45)	Statistical significance (p)
Bone integration (6/9 months)	10/37	18/27	0.0846*
Number of implants - average (SD)	4.1 (3.2)	2,6 (1.4)	0.0033**
<i>Method of bone volume reconstruction - no. of patients (%)</i>			
Sinus lift	19 (40.4)	16 (35.6)	0.7901*
Bone augmentation	24 (51.1)	15 (33.3)	0.1312*

SD = standard deviation; * - chi-square test with Yates' correction; ** - Student's t-test for independent groups

Table III. Postoperative outcome of patients in the two study groups.

	Group I (n=47)	Group II (n=45)	Statistical significance (p)
Maximum pain intensity (mild / moderate / severe)	0/34/13	3/37/5	0.0361*
Duration of pain maximum (days) - average (SD)	2.6 (1.5)	3.0 (2.1)	0.3100**
Maximum bleeding intensity (mild / moderate / severe)	41/6/0	39/6/0	0.8190*
Maximum bleeding duration (days) - median (IQR)	3 (2-4)	3 (2.5-4)	0.9410***
<i>Inflammatory complications - no. of patients (%)</i>			
Edema	35 (74.5)	33 (73.3)	0.9096****
Ecchymosis	12 (25.5)	14 (31.1)	0.7170****
Inflammation	20 (42.6)	17 (37.8)	0.7993****

* - chi-square test; ** - Student's t-test for independent groups; *** - Mann-Whitney test; **** - chi-square test with Yates' correction

**Figure 3.** Postoperative inflammatory complications for patients in the two study groups.**Table IV.** Independent risk factors that may lead to compromised implant-retained restorations in patients in the two groups.

	Group I (n=47)	Group II (n=45)	Statistical significance (p)
Occurrence of gingival inflammation at follow-up - no. of cases (%)	23 (48.9)	21 (46.7)	0.9928*
First occurrence of gingival inflammation at follow-up (years) - median (IQR)	2 (2-3)	2 (2-3)	0.6374**
Onset of gingival recession at follow-up (yes / no)	0 (0)	17 (37.8)	<0.0001*
First occurrence of gingival recession at follow-up (years) - median (IQR)	-	5 (3-5)	-
Compromised rehabilitation at follow-up (yes / no)	3 (6.4)	11 (24.4)	0.0340*
Mean lifetime of the rehabilitation (years) - median (IQR)	10 (10-10)	10 (10-10)	0.0137**

IQR = interquartile range; * - chi-square test with Yates' correction; ** - Mann-Whitney test

The only statistically significant difference was observed in the maximum intensity of postoperative pain, which was significantly more intense in patients in group I (dental implant-based rehabilitation only). By contrast, the characteristics and duration of bleeding did not show significant differences. Inflammatory complications were observed with similar frequencies for the two groups of patients (Figure 3).

The long-term evolution is aimed at the development of gingival inflammation around the implant-prosthetic reconstruction, gingival recession, and compromise restoration. The data recorded in this regard is listed in table IV.

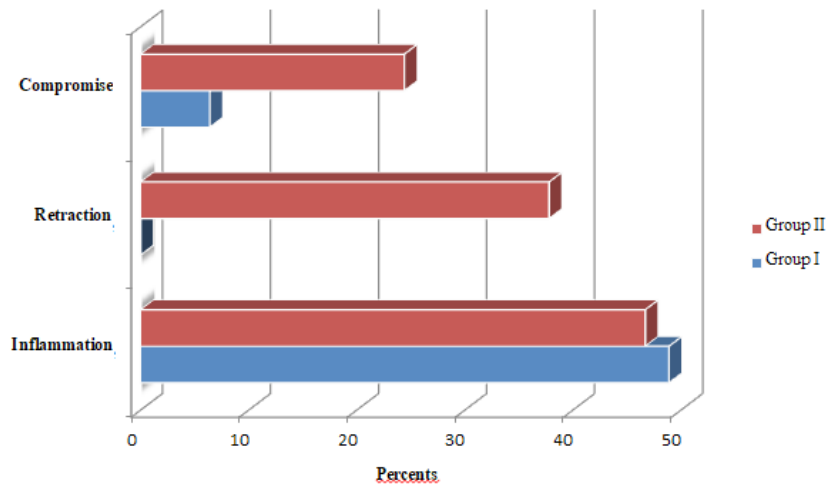


Figure 4. Late complications for two study groups.

The occurrence of gingival inflammation is a common phenomenon at follow-up checks (almost 50% incidence) both among patients who received prosthetic reconstruction on dental implants alone and on implants plus abutment teeth. This complication appears approximately every two years for both groups. In contrast, only patients with abutment teeth under prosthetic reconstruction experienced gingival recession at the controls. Complications leading to compromised prosthetic reconstruction were significantly more frequent in patients in the second group (6.4% vs. 24.4%) (Figure 4).

In order to analyze the risk factors that contribute to the compromise of the prosthetic reconstruction, it was constructed a logistic regression model, introducing the following variables: age, gender, background, comorbidities, causes of edentulism, method of bone volume reconstruction, and the way of reconstruction. The result of this model provides the independent risk factors with the specific relative risk for each (Table V). This means that using dental implants and natural abutment rehabilitation increases the risk of compromise by about 43 times compared to the dental implant modality, while the presence of diabetes increases by about 20 times and the presence of osteoporosis by 32 times.

Table V. Independent risk factors for prosthetic compromising rehabilitation.

Variability	Relativ risk	Confidence interval 95%
Diabetes mellitus	19.88	2.55 – 155.06
Group II	43.19	3.88 – 482.22
Osteoporosis	32.30	2,51 – 415.39

Discussion

This study is a statistical analysis of the distribution of cases based on bone integration (osseointegration), which allows to discuss the prosthetic loading of inserted implants. It was revealed that a significant number of cases, involving extensive reconstruction of the alveolar maxillary and mandibular ridges on extended territories, bimaxillary, complex implant-prosthetic reconstruction, and patients with various associated diseases, achieved bone integration at 9 months, accounting for 30.43% of cases. Osseointegration is particularly important in order to achieve long-lasting dental implants and a strong bone that can withstand the prosthetic load. According to the comparative study, the duration of osseointegration was similar for the two groups, with the majority lasting 9 months. The number of implants was obviously higher in cases with dental implant-only rehabilitation, but the method of reconstruction required for the bone volume had a similar distribution for the two reconstruction modalities. Also, we conducted a statistical analysis of the distribution of cases based on the type of implant-prosthetic reconstruction in oral rehabilitation (implant prosthetic reconstruction, implant - teeth prosthetic reconstruction). Based on the implant-prosthetic treatment plan, 47 cases, out of 92 total, underwent oral rehabilitation solely on implants, accounting for 51.1% of the total. It was decided to perform implant-prosthetic rehabilitation in 45 cases, which included both implants and abutment teeth. These have a 48.9% percentage representation. According to various studies conducted in recent years, implant-only restorations remain the best option for implant-prosthetic oral rehabilitation, as they insert the implants into the receiving bone bed without damaging healthy teeth.

In situations of cases with moderate or severe atrophy of the alveolar ridges, we have at our disposal numerous methods of bone addition and surgical techniques to be able to increase in height and width the bone volume necessary for the insertion of dental implants. The methods for bone augmentation techniques are chosen according to the topography of the edentulous dentition, the anatomical shape of the alveolar ridge and the peculiarities of the maxillary bone, as well as the cause of tooth loss [11-15]. It is important for the specialist to carefully assess the preoperative dento-periodontal status in correlation with the patient's general health status and the local and general conditions from which the patient is suffering [16]. Early assessment is important in order to apply appropriate treatment methods. Any alteration of the soft and hard tissues affects the final result, and for this reason, for full success, it is imperative to have a thorough knowledge of the anatomy of the jaw bones, with their anatomical peculiarities, their loco-regional anatomical features, their vascularization and innervation, the processes of bone atrophy and resorption in the jaws, neo-osteogenesis phenomena in the case of grafts, the structure of peri-implant soft tissues, oral mucosa, types of epithelia, knowledge of pre-implant surgical techniques, and the correct establishment of an individualized surgical plan in relation to the clinical case [17-20]. When choosing the technique and the bone addition material, many a factor should be taken into account, such as periodontal disease, systemic factors, volume and quality of the remaining bone [21-23].

Conclusions

Within the limitations of this study, it can be concluded that:

1. As associated pathology only arterial hypertension was significantly more frequent in group I patients (derived from older age).
2. The most common cause of edentulism remains periodontal inflammatory lesions followed by poor oral hygiene and other oral-gingival mucosal diseases.
3. In terms of bone supply, a much more pronounced decrease is observed in patients with dental implant-only rehabilitation.
4. The duration of osseointegration was similar for the two groups, the majority being 9 months. The number of successful implants was obviously higher for the cases with dental implant-only reconstruction. The method of required bone volume reconstruction had similar distribution for both methods.
6. The only statistically difference was observed in the maximum intensity of postoperative pain, which was significantly more intense in patients in group I (dental implant-only reconstruction). By contrast, the characteristics and duration of bleeding did not show significant differences.

7. Inflammatory complications were observed with similar frequencies for the two groups of patients

8. Long-term evolution deals with the occurrence of gingival inflammation around the implant-prosthetic rehabilitation, gingival recession and compromise of the reconstruction.

9. The occurrence of gingival inflammation is a common phenomenon at follow-up (almost 50% incidence) both among patients who received prosthetic reconstruction on dental implants alone and on implants plus abutment teeth. Occurrence of complications is approximately after 2 years for both groups.

10. On the other hand, the occurrence of gingival recession at follow-up checks was observed exclusively in patients with abutment teeth under the prosthetic reconstruction.

11. Complications leading to compromised prosthetic rehabilitation were significantly more frequent in patients in the second group (6.4% vs. 24.4%).

12. The use of the abutment-tooth method with dental implants for prosthodontic reconstruction increases the failure by about 43 times compared to the dental implant modality rehabilitation; while the presence of diabetes mellitus increases by about 20 times and the presence of osteoporosis by 32 times.

References

1. Yeung CA. Effect of implant rehabilitation on oral health-related quality of life with three different implant strategies. *Evid Based Dent.* 2020;21:92-93.
2. Wennerberg A, Albrektsson T. Current challenges in successful rehabilitation with oral implants. *J Oral Rehabil.* 2011;38:286-294.
3. Augustin M, Carabela M, Olteanu I, Iorgulescu D, Ene S. *Implantele endosoase osteointegrate în stomatologie [Endosseous implants in dentistry]*. Ed. Sylvi, 1995; 55-70. [Romanian]
4. Gănuță N, Bucur A, Gănuță A. *Tratat de Implantologie Orală [Treatise of oral implantology]*. Editura Național, – Bucuresti, 1997; 250-268. [Romanian]
5. Augustin M. *Implantologia Orală, Curs.* [Course of oral implantology] Editura Sylvi 2000; 147-166. [Romanian]
6. Sîrbu I. *Curs de Implantologie Orală [Course of oral implantology]*. București, 2004; 63-88. [Romanian]
7. Crăițoiu Ș, Florescu M, Crăițoiu M. *Cavitatea Orală-Morfologie Normală și Patologică-Note de Curs [Oral cavity – Normal and pathological morphology. Lecture notes]*, Ed. Medicală, București, 1999; 30-54. [Romanian]
8. Bucur A, NavarroVila C, Lowry J, Acero J. *Compendiu de Chirurgie Oro – Maxilo – Facială. vol. 1 and vol. 2.* Q Med Publishing, 2009, Bucuresti. I: 223 – 228., 129, 8: 133 – 138, 11: 205 – 231. [Romanian]
9. Al Ansari Y, Shahwan H, Chrcanovic BR. Diabetes Mellitus

- and Dental Implants: A Systematic Review and Meta-Analysis. *Materials* (Basel). 2022;15:3227.
10. Zinner Id, Panno Fv; Small Sa; Landa Ls. *Implant Dentistry: From Failure To Success*. Quintessence, 2004; 138-164.
 11. Ortiz-Puigpelat O, Barroso-Panella A, Altuna-Fistolera P, Quevedo-Pou M, Hernández-Alfaro F. The Screen Technique for Safe Bone Regeneration of Noncontained Defects: A Novel Technique. *Int J Periodontics Restorative Dent*. 2021;41:857–862.
 12. Landsberg C, Moses O. Ridge Augmentation Using Customized Allogeneic Bone Block: A 3-Year Follow-up of Two Case Reports. *Int J Periodontics Restorative Dent*. 2020;40:881-889.
 13. De Angelis N, Kassim ZH, Baharuddin IH, Parker S, Colombo E, Amaroli A, et al. Ten-Year Results of a Prospective Cohort Study on Acid-Etched and Airborne Particle-Abraded Implant Surfaces: A Comparative Study. *Int J Periodontics Restorative Dent*. 2020;40:e189–e196.
 14. Alqahtani M. Influence of Soft Tissue and Crestal Bone Resorption in Moderate Cigarette-Smokers and Nonsmokers: A 5-Year Study. *Int J Periodontics Restorative Dent*. 2021;41:895–900.
 15. Romito GA, Sapata VM, Cesar Neto JB, Llanos AH, Jung RE, Pannuti CM. Simultaneous Assessment of Soft and Hard Tissue Behaviors After Alveolar Ridge Preservation Using Bone Substitutes. *Int J Periodontics Restorative Dent*. 2022;42:103–111.
 16. Sakai H, Kurita H, Kondo E, Tanaka H, Shimane T, Hashidume M, et al. Dental and oral management in the perioperative period of surgery: A scoping review. *Jpn Dent Sci Rev*. 2024;60:148-153.
 17. Artese HP, Foz AM, Rabelo Mde S, Gomes GH, Orlandi M, et al. Periodontal therapy and systemic inflammation in type 2 diabetes mellitus: a meta-analysis. *PLoS One*. 2015;10:e0128344.
 18. Schropp L, Wenzel A, Kostopoulos L, Karring T. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. *Int J Periodontics Restorative Dent*. 2003;23:313-323.
 19. Suresh N, Chandrasekaran B, Muthusamy S, Kannan S, Muthu K. Application of platelet rich fibrin for management of an electrosurge induced osteonecrosis involving maxillary alveolus. *Singapore Dent J*. 2015;36:39-43.
 20. Tan WL, Wong TL, Wong MC, Lang NP. A systematic review of post-extractonal alveolar hard and soft tissue dimensional changes in humans. *Clin Oral Implants Res*. 2012;23 Suppl 5:1-21.
 21. Lemons JE. Ridge Augmentation versus permucosal implants in preprothetic surgery, in tissue integration in oral and maxillofacial reconstruction. *Excerpta Medica, Brussels* 1985, 394–397.
 22. Puterman I, Fien M, Mesquida J, Llansana F, Bauza G, Nevins M. The Use of a Collagen Scaffold to Augment Buccal Ridge Contour Concurrently with Implant Placement: A Two-Case Report. *Int J Periodontics Restorative Dent*. 2021;41:827–833.
 23. Sadan A, Blatz MB, Salinas TJ, Block MS. Single-implant restorations: a contemporary approach for achieving a predictable outcome. *J Oral Maxillofac Surg*. 2004;62(9 Suppl 2):73–81.