A Comparison between Endodontics and Implantology: An 8-Year Retrospective Study

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ABSTRACT

Purpose: The aim of this study was to compare endodontic and implant treatments and to evaluate their predictability over an 8-year period on the basis of an analysis of survival data and a retrospective clinical study.

Materials and Methods: A group of 40 partially edentulous patients were selected for this study. Their teeth had been endodontically treated and rehabilitated using gold alloy and ceramic restorations. In these patients, 65 osseointegrated implants were restored with single gold alloy–ceramic crowns and monitored on a yearly basis for 8 years with standardized periapical radiographs, using a polivynilsiloxane occlusal key as a positioner. A total of nine patients who did not attend the yearly follow-up were excluded from the study. The Melloning and Triplett criteria were used to evaluate the clinical results obtained in the implant sites. The clinical results of the 56 endodontically treated teeth, restored with the fixed prosthesis of 40 patients, were analyzed according to probing depth as well as an assessment of the correct apical and coronal seals. The survival rate was calculated using the Kaplan–Meier method and the statistical significance was calculated using the chi-square test.

Results: During the follow-up of the endodontically treated elements, seven failures were detected (83.34%) and the success rate of implants inserted in the same patients was equal to 80.8%, with nine implants lost in 8 years. The survival analysis of the elements treated with both therapies was not statistically significant ($p = .757$) and the confidence interval was between 0.2455 and 2.777.

Conclusion: In view of the superimposable results between the two therapies, it should be noted that the endodontically treated teeth could be interested by different pathologies while the restoration of the atrophic edentulous ridge with an implant support is predictable when patients comply with correct oral hygiene and when the occlusal loads are axially distributed in implant-protected occlusion.

KEY WORDS: endodontics, follow-up, natural dental elements, osseointegrated implants, survival rate

INTRODUCTION

An ongoing controversy in dentistry is whether root canal treatment and restoration can compete for long-term success with prosthetic crowns supported by an implant. Current trends in implantology have weakened this paradigm because many operators have adopted implants as standard treatment. Many short-term studies have reported favorable data supporting the success of dental implants, but the lack of standardized evaluations makes it difficult to compare these studies objectively.[1] On the other hand, the development of modern endodontic techniques for conventional treatment and subsequent re-treatment has allowed the maintenance of a number of teeth that in the past would have been extracted.[2]

It seems that there are no standardized studies in the literature to compare endodontic success rates over a number of years. Despite the restrictive criterion used in radiography to determine the success of endodontic treatment, namely the absence of periapical radiolucency, Ng et al.,[3] in an extensive review of the literature, observed that success rates varied from 68% to 85%.

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Endodontic epidemiological studies conducted in different populations around the world have shown that periapical status is also related to factors such as the quality of root canal treatment of coronal restoration and the presence of intracanal posts.[4,5] Stassen et al.[6] have reiterated the importance of high quality in the treatment of coronal and root canals, stressing that sufficient care should be taken to seal the coronal cavity up to the level of the root filling, or at least to the level of the surrounding marginal bone. It is important to underline that in determining the success of endodontic treatment, the following are false contraindications: iatrogenic injuries (perforations caused during root canal preparation, instrumentation of the canal, or preparation of the space for the post and fractured instruments); anatomical abnormalities caused by the root form and root canal curvature; and lastly canal calcification.[7,8]

In a retrospective study of 2,000 cases, Imura[9] evaluated the outcome of initial endodontic treatment and that of non-surgical re-treatment. The overall success rate of endodontic treatment over a minimum of 2 years was 91.45%. The 2,000 cases, of which 1,376 teeth belonged to the sample of initial endodontic treatment and 624 to the non-surgically re-treated teeth, produced a success rate of 94.0% and 85.9%, respectively. The success of endodontic treatment and restoration requires a great deal expertise on the part of the practitioner. Multivariate analysis has identified procedural complications (such as the rupture of files or drill, as well as flare-ups) and the absence of restorations at follow-ups, as significant factors in results with lower success rates. Friedman[10] showed that the ability of the teeth without AP to remain disease-free after initial treatment or orthograde re-treatment varies between 92% and 98%. The possibility of teeth with AP to heal completely after initial treatment or re-treatment is 74%–86%, and their ability to be functional over time is 91%–97%. The possibility of teeth with AP to completely heal after apical surgery varies from 37% to 85%, with a weighted average of approximately 70%. However, even with the lowest probability of complete healing, the ability for teeth to be functional in time is 86%–92%.

Nonetheless, in cases where the root canal treatment fails, there is always the possibility of inserting an implant that has a similar success rate. In a systematic review of the literature, Porter[11] has outlined the criteria for implant success and failure. Success is related to the quality and quantity of bone at the implant site, the length and the diameter of the implant, the axial load and the maintenance of a correct oral hygiene. The criteria for failure are due to the following factors: periodontal disease, smoking, systemic diseases, infections, ageing, parafunctions, short implants, inadequate number of implants, lack of integration with hard and soft tissues, and inappropriate prosthetic design. Esposito et al.[12] identified 40 different randomized controlled trials (RCT) from the Cochrane central register of controlled trials and compared 18 types of different implants, with a follow-up ranging from 1 to 5 years. They concluded that there is no evidence that any one type of dental implant has a higher long-term success rate compared with another. Lekholm et al.[13] examined the results of 69 implants in 27 partially edentulous patients after 20 years. The cumulative survival rate was 91%, with six failures (8.7%) occurring during the 20-year period (four in the first decade, and the remaining two in the second), of which four resulted from fractures (two after 8 years, and two after 17 years).

As regards immediate dental implants in partially edentulous patients, Carrillo García et al.[14] have made a significant update in the current literature. A mean survival rate of 95.39% was observed. Despite the high success rate, there still remains a big debate regarding the few existing studies and limited follow-up periods. The following authors can be cited as contributors to the number of case studies in the literature. Jemt[15] reported a clinical study of single implants placed in the anterior maxilla after 15 years of follow-up. The experimental group consisted of 38 consecutive patients with 47 single implant crowns in the anterior maxilla. In the control group of 76 edentulous patients, one of the central implants (nearest the midline) was randomly selected. No implant was lost in the experimental group (cumulative success rate: 100%), while three implants were lost in the control group (cumulative success rate: 95.4%). Schwartz-Arad et al.[16] have also reported a survival rate of 97.6% in 87 post-extraction implants with a follow-up period of 6 to 52 months. Moreover, Rosén et al.[17] observed a 97% success rate over 10 years in 103 implants located in 19 upper severely atrophic edentulous ridges. Lastly, Romeo et al.[18] found a survival rate of 97.9% and 97.1% respectively in 111 short implants (8 mm in length) and 154 implants (10 mm standard length) with a 14-year follow-up period.

The clinical efficacy of single dental implants in sites where implants had previously failed has been evaluated by Grossmann and Levin.[19] The study was based on 1,387 single implants assessed over 6 years (1999 to 2005) and, with the failure of nine implants, resulted in a survival rate of 71%. The follow-up ranged from 6 to 46 months. Consequently, the authors concluded that repositioning a failed implant presents* a challenge to achieve osseointegration in a healed bone site and may result in a decrease in the survival rate. Even Machtei et al.[20] assessed dental implants in previously failed sites: 56 patients with a total of 79 implants to be repositioned were included in this study. These implants were followed for 7 to 78 months. Thirteen implants failed and resulted in an overall survival rate of 83.5%. The implants that successfully osseointegrated had a larger diameter (4.05 mm) compared to the failed ones (3.72 mm). Anitua et al.[21] assessed the long-term survival of 5,787 implants by performing an analysis of implant, surgical, and patient failure. Survival rates of Biotechnology Institute implants were 99.2%, 96.4%, and 96% respectively. If, in the case of failure, implant treatment is immediately chosen as the primary solution, the long-term success rate decreases in sites where implants had previously failed. Doyle et al.[22] in a retrospective study compared 196 single implant restorations and 196 initial non-surgical root canal treatment (NSRCT). The results were as follows for implants and for NSRCT respectively: success 73.5% and 82.1%; survival with no intervention 2.6% and 8.2%; survival with intervention 17.9% and 3.6%; failure 6.1% and 6.1%.† This study suggests that endodontically treated teeth and single implant restorations have similar failure rates, even if the group of implants showed a higher incidence of post-treatment complications requiring a subsequent intervention.

The same conclusion was drawn by Hannahan[23] comparing 129 implants (36-month follow-up) with 143 endodontically treated teeth. The success rate was, respectively, 98.4% and 99.3%; however, 12.4% of implants against 1.3% of devitalized teeth required subsequent interventions. These studies show, therefore, that it is not justified to say that the success of endodontic therapy is higher or lower compared to implants, or that this assumption should form the basis of treatment planning. The decision whether to preserve and restore, or replace, might be better indicated by the restorative prognosis of the tooth itself, and the characteristics of the loading that it will have to bear,[24] keeping in mind that one of the main causes of implant failure is the occlusal overload.[25,26] The aim of this study was to compare these two treatments and assess their predictability over 8 years on the basis of a retrospective clinical study and data survival analysis.

MATERIALS AND METHODS

The present cross-sectional retrospective study included 520 patients who had been treated with 1,325 dental implants since 1997 at the Department of Prosthodontics, School of Dental Medicine, University of Rome La Sapienza. A group of 40 patients with partially edentulous arches were subsequently selected. These patients were treated with 65 osseointegrated implants connected each other, restored with single gold alloy–ceramic crowns, and monitored for 8 years (Table 1). The selected patients had in the same dental arch at least one tooth which had been endodontically treated and rehabilitated with single gold alloy and ceramic restorations. This group of subjects was composed of individuals of both sexes, aged between 22 and 65, non-smokers, healthy or suffering from a previous periodontal disease (periodically monitored). All patients signed a written consent form. Each case was accurately evaluated examining diagnostic casts to assess the inter-arch relationship; moreover, panoramic radiographs and computed tomography were taken. Following these analyses all the patients underwent the necessary dental treatment to provide an oral environment more favorable to wound healing.

Furthermore, all patients agreed to undergo a follow-up to assess the health of periodontal tissues, the quality of oral hygiene and to perform the necessary intraoral radiographs. The latter were necessary to check

TABLE 1 Total Number, Section and Length of the Osseointegrated Implants Inserted and Distributed in the Two Arches of the 40 Initial Patients

Maxillary Implants	Mandibular Implants	Ø	Length	Total Number
7	1	4.0 mm	12 mm	8
14	8	3.75 mm	12 mm	22
15	10	3.75 mm	10 mm	25
2	5	3.75 mm	8 mm	7
0	3	3.25 mm	10 mm	3

TABLE 2 Total Number of the Endodontically Treated Teeth Restored with Gold–Ceramic Crowns and Distributed in the Two Arches of the 40 Initial Patients

Maxilla			Mandible			
Incisors and Canines	Premolars	Molars	Incisors and Canines	Premolars	Molars	Total Number
6	12	11	2	12	14	56

TABLE 3 Endodontic Therapies in the Group of 31 Patients Who Attended on a Yearly Basis the 8-Year Follow-Up

Maxilla			Mandible			
Incisors and Canines	Premolars	Molars	Incisors and Canines	Premolars	Molars	Total Number
6	8	8	2	8	10	42

perimplant bone resorption and to verify the validity of the 56 endodontically treated elements, including the marginal closure of the prosthetic restoration (see Table 2). Patients were monitored for a period of 8 years; nine patients were excluded from the study because they dropped out. Therefore, the study was only performed on 31 patients with 47 osseointegrated implants and 42 endodontically treated teeth, all restored with gold–ceramic crowns (Tables 3 and 4). The first periapical radiograph was made immediately after implant insertion, and subsequently at an interval of every 12 months. At the same time, occlusion checks were executed. To obtain a proper clinical evaluation for both endodontic therapy and inserted osseointegrated implants, intraoral periapical radiographs were taken. These were standardized with the use of a suitable positioner (Endo-Pro®, Roseville, CA, USA) and by applying a radiographic device with a long cone (75A) to maintain the same inclination. To standardize the positioning and direction of radiographs, an occlusal recording was executed using polivynilsiloxane as a positioner (bite registration material, ColorBite D) (Figure 1). In this way, for each patient, the support was customized, cold-sterilized and stored for subsequent follow-ups (Figures 2 and 3).

The patient was actively encouraged to maintain good oral hygiene at home, with a check-up call after a month on the less motivated ones. To evaluate the clinical results obtained in the implant sites the same criteria used by Melloning and Triplett[27,28] were applied and the measurements were performed with a manual calibration, using the upper edge of the first implant thread as a landmark:

- complete success: complete implant coverage;
- partial success: <3 mm exposed implant surface;
- implant failure: >3 mm exposed implant surface.

The following criteria were used to analyze the clinical results of the 31 patients with 56 natural elements endodontically treated and restored with fixed prosthesis: probing depth, evaluation of both the proper apical seal using an endoral X-ray[1] and coronal seal by verifying the attachment loss and marginal gaps.[3]

TABLE 4 Number of Osseointegrated Implants Inserted in the Group of 31 Patients Who Attended on a Yearly Basis the 8-Year Follow-Up

Maxilla			Mandible			
Incisors and Canines	Premolars	Molars	Incisors and Canines	Premolars	Molars	Total Number
6	11	9	2	9	10	47

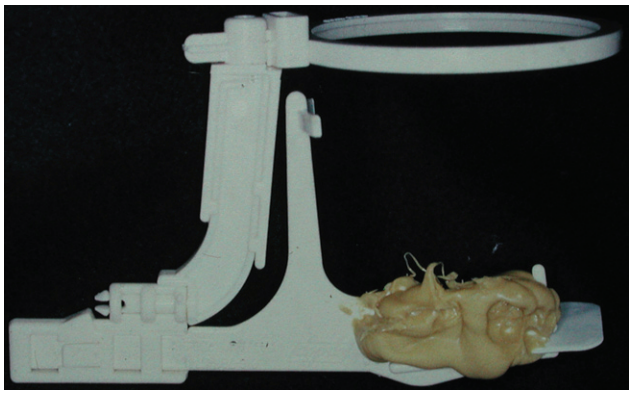

Figure 1 Polivynilsiloxane occlusal key.

Figure 3 Occlusal key with X-ray positioner.

Statistical Analysis

The survival rates of the 2 groups studied were calculated using the Kaplan–Meier method.[29] The logarithmic classification test (log rank test) was applied to determine whether some functions of survival differed between the groups.[30] Statistical significance was calculated with the Chi-Square test and the confidence interval CI was set at 95%. The level of significance was put at $p = .05$. The software used was GraphPad Prism Version 4.0 (GraphPad Software, San Diego, CA, USA).

RESULTS

To evaluate the clinical results in 31 patients who completed the annual follow-up planned over the 8 years, 341 periapical standardized radiographs were analyzed. During the follow-up of the 56 endodontically treated teeth, 4 endodontic failures were found due to an incorrect apical seal and 3 failures due to marginal infiltration of the fixed restoration resulting from an interproximal marginal gap of the restored dental element (Table 5). The measurements of the standardized periapical X-rays, performed with a decimal gauge, established a total of nine failures after 8 years on all osseointegrated implants inserted (Table 6). The Kaplan–Meier survival curve did not give statistically significant results ($p = .757$) and the confidence interval was between 0.2455 and 2.777. Comparing the survival curve of endodontically treated teeth with the implant rehabilitations over 96 months (8 years), it can be seen that the two curves are superimposable in the absence of statistically significant differences (Figure 4). Finally, from among the 31 patients monitored over 8 years, two significant clinical cases were illustrated (Figures 5–8).

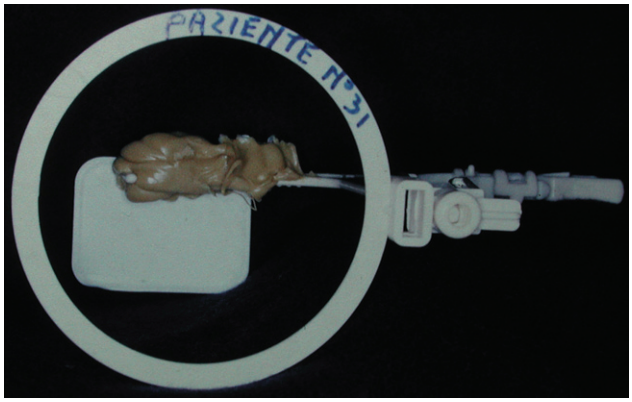

Figure 2 Standardized occlusal registration on a patient.

TABLE 5 Endodontically Treated Teeth Lost over 8 Years of Experimentation

Endodontically Treated Lost Teeth		
Maxilla	Mandible	Total Number
4	3	7

TABLE 6 Number of Osseointegrated Implants Lost over 8 Years of Experimentation

Osseointegrated Lost Implants		
Maxilla	Mandible	Total Number
6	3	9

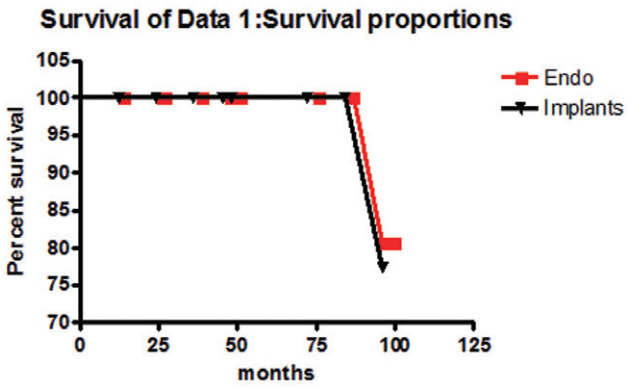

Figure 4 Survival curve of the elements treated with two therapies.

DISCUSSION

In modern dental practice, there is a tendency to remove severely decayed teeth. This inevitably involves the sacrifice of many dental elements that might otherwise be recovered.[1,16,24] The tendency to place implants where it is still possible to preserve the natural tooth is probably due to the high level of specialization required to perform endodontic therapy and the high accuracy needed in the subsequent restoration. However, this does not justify the daily practice of replacing natural teeth with implants. Though easier to perform, unnecessary surgical interventions could be avoided if the patients' natural elements were recovered. In the evaluation of 341 periapical intraoral radiographs, a percentage of success equal to 83.34% in endodontically treated and restored teeth was obtained (as assessed in the 8 years of this study) because seven natural elements had been lost (Table 5).

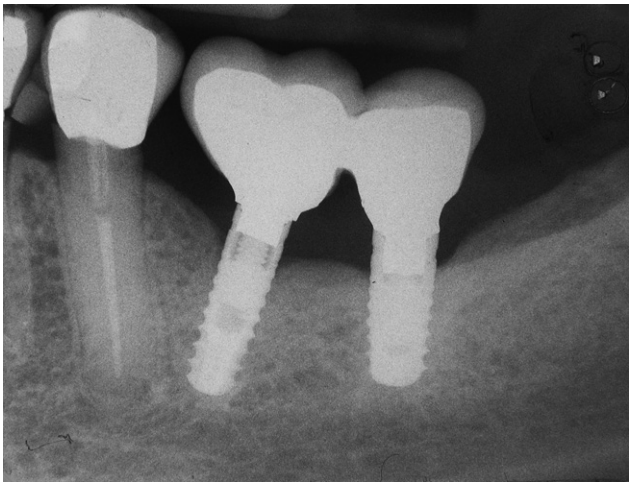

Figure 5 Female patient aged 58 years. One-year follow-up of the endodontic, implant, and prosthetic therapies executed in the year 2000.

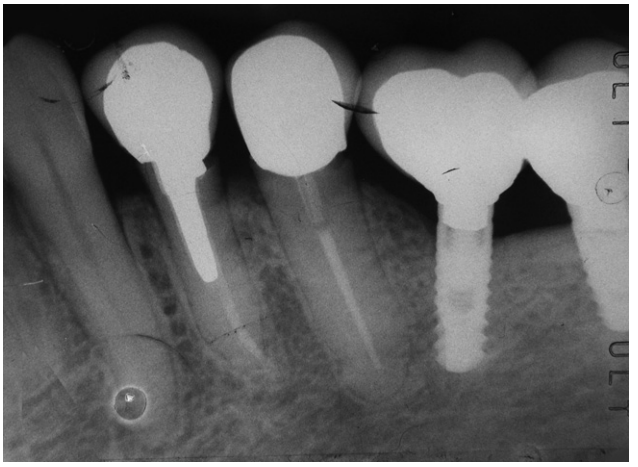

Figure 6 The same patient as in Figure 5. X-ray follow-up executed during the 8th year.

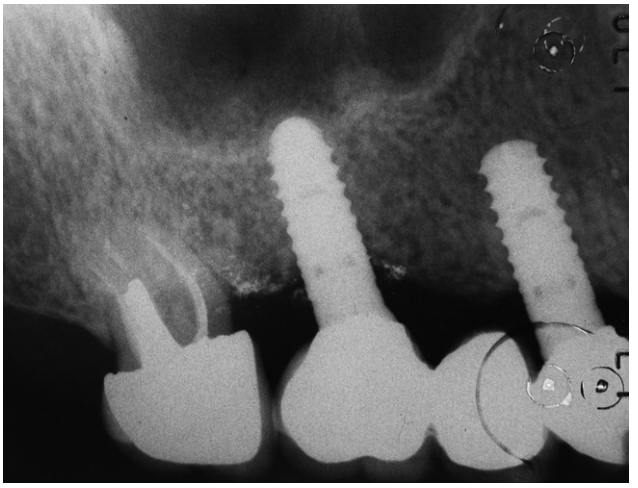

Figure 7 Male patient aged 62 years. One-year follow-up of the endodontic, implant, and prosthetic therapies executed in the year 1999.

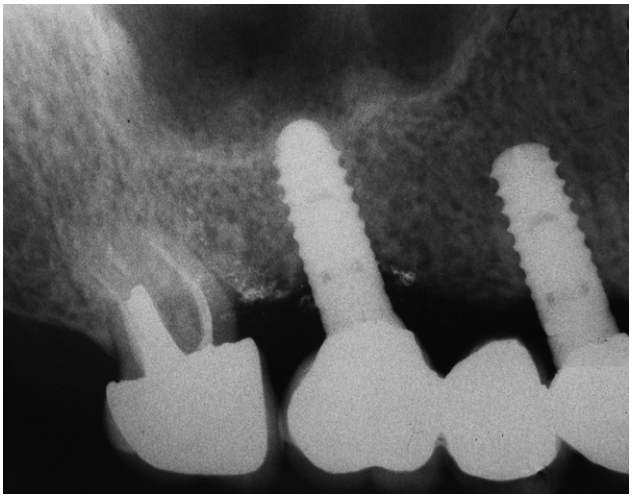

Figure 8 The same patient as in Figure 7. X-ray follow-up executed during the 8th year.

The findings from this study are somewhat lower than the average reported by other researchers[4,5,22] but this could be explained by the fact that it took place over 8 years and included patients with previous periodontal problems (periodically monitored). The success rate of implants inserted in the same patients, who also had endodontic treatments performed (before or during the implant therapy) and evaluated over the 8 years, is equal to 80.8% with nine implants lost in 8 years (Table 6). This percentage is slightly lower than that estimated by other authors,[13,15,17] but it is well known that after the placement of the prosthetic rehabilitation, the patient forgets that his teeth are artificial and decreases his commitment towards a correct oral hygiene. Comparing clinical results and survival curves of the endodontically treated and rehabilitated elements to those of restored implants over the 8 years, the two treatments are in fact equivalent. However, an important consideration to bear in mind is that if you lose an implant, it is difficult to re-insert it in the same position whereas if you lose endodontically treated teeth with current surgical techniques, implants can be inserted in the same location where the teeth were before.

On Figures 5 and 6, it is shown that a clinical case among 31 patients who completed 8-year follow-up where two osseointegrated implants where connected each other in order to avoid any unscrewing of the screw between the implant and abutment.

During functionalization the method of the implant-protected occlusion (IPO) was followed where premature contacts were eliminated using 25 μ thick articulation paper and a greater load was exerted on the adjacent natural teeth during excursion movements.[31–33] This method allows occlusal forces in the centric position to be placed along the axial direction. All prosthetic structures were made rigid and the occlusion was modeled in order to minimize the displacement of occlusal forces. In Figures 7 and 8, two osseointegrated implants were connected to each other with a rigid restoration in order to substitute a missing natural element of the upper arch.

CONCLUSION

Although the present study was carried out on a comparatively small number of patients and for a limited period of time, the preliminary findings may still be combined with those obtained from a more comprehensive study in the future. As previously mentioned, endodontic and implant therapies have been shown to give superimposable results. Furthermore, a successful restoration of the atrophic edentulous ridge with implant support is dictated by the patient's maintenance of correct oral hygiene and a proper distribution of occlusal loads. In fact, the lateral forces created by a natural tooth intrusion of 28 μ and implant of 5 μ produces a 56 to 108 μ shift of the natural element and just a 10 to 50 μ shift on the osseointegrated implant.[34,35] The present study, therefore, confirms that the longevity of implant prostheses can be increased by maintaining an axial distribution of the chewing loads as indicated by the IPO method.

Nickenig et al.,[36] in 6.7-year-follow-up of over 459 implants and 449 natural elements, showed the same survival between the prosthesis on implants and that one on natural teeth and implants, but a greater risk as a result of biological complications due to incorrect endodontic therapy or previous periodontal diseases. From our comparative follow-up, although incomplete because about a reduced number of patients, endodontically treated natural elements restored with fixed prosthesis had a greater tendency to endoperiodontal pathologies and fractures compared to implant-supported restorations.

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