Clinical and radiographical comparative evaluation of implant-connected versus tooth-connected implant supported partial dentures

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Abstract

Purpose: To compare implant connected and tooth connected implant supported fixed-detachable mandibular partial dentures clinically and radiographically.

Materials and methods: 20 partially edentulous patients with age range (25–50) years old of mandibular class II Kennedy classification were equally divided into two groups receiving a three unit fixed detachable screw retained partial denture, Group (I): Patients with unilateral missing mandibular molars and premolars. Two implants were placed at the mandibular first premolar and first molar areas. Group (II): Patients were selected with missing mandibular molars and second premolar, having the mandibular first premolar in a good periodontal health and good bone support. An implant was placed at the mandibular first molar area and preparation of the first premolar was done and a coping was cemented to the tooth with permanent cement. Each case was evaluated clinically and radiographically at base line (partial denture insertion) and after 3, 6 and 12 months. Data were collected and statistically analyzed using repeated measures way ANOVA test.

Results: There was no statistical significance difference between the two groups (P > 0.05).

Conclusions: The tooth-implant supported prosthesis shows predictable treatment option as the totally implant-supported prosthesis concerning implant survival and loss of marginal bone.

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Keywords: Fixed-detachable prosthesis; Implant tooth connection; Rigid connection; Screw retained; Tooth intrusion

1. Introduction

For patients with missed posterior teeth, many treatment options are available. The existing situation can be maintained by stabilizing the present dentition and improving the occlusion without extending the arch. Alternatively, the missed teeth can be replaced by either a free-end saddle removable partial denture [1–4], cantilevered fixed bridge [5,6], tooth supported overdentures [7] or by an implant-supported prostheses [8]. To date, it is not yet clear what is the optimal
treatment modality for the management of missed posterior teeth.

Implant therapy using osseointegrated implants has provided clinicians with a predictable treatment alternative for edentulous and partially edentulous patients. Using implants in partially edentulous patients led to a clinical dilemma: whether or not to connect to a natural tooth as an abutment for an implant-supported fixed partial denture [9].

The tooth-implant supported prosthesis gains attention from patients and practitioners because of economic as well as clinical reasons [10]. But unlike a tooth, which is cushioned by flexible periodontal ligaments, an osseointegrated implant is ankylosed to the bone and is, therefore, virtually immobile. So, while teeth may move to accommodate splinting inaccuracies of a fixed partial denture, this is less possible with implant-supported restorations [11].

There are situations in partial edentulism where a tooth implant supported fixed partial denture may be a rational alternative. Patients with severe gag reflexes, patients who require complete-arch restorations and have a limited number of remaining teeth in unfavorable positions for treatment with conventional fixed partial dentures may also, after placement of implants, be provided with tooth- and implant-supported prostheses [12,13], the need to splint mobile teeth, alveolar bone deficiency, refusal of the patient to agree to augmentation procedures, and financial constraints limiting the number of implants and/or type of augmentation procedures indicated [14,15].

On the other hand, a series of engineering and physiological complications associated with the implant-tooth connection were reported involving abutments screw loosening, prosthesis or implant fracture, cement failure, peri-implantitis, loss of osseointegration, increased marginal bone loss may also occur around the implant, periodontitis and caries of natural tooth [16—19]. The most important complication that has gained considerable interest is natural tooth intrusion [9,20,21].

In-vitro and in-vivo studies compared rigid versus non-rigid connection between natural teeth and implants revealed conflicting results. While some authors suggested non rigid connection to be solution for tooth intrusion [22—24], Naert and his coworkers [25,26], put researchers against a dilemma. From results of his clinical evaluation (Part I) [25] of the study, they concluded that, if connection between teeth and implant is considered, a rigid connector is favored for its lower complications (i.e. intrusion) were observed. However, the results of the radiographical evaluation of their (Part II) [26] of the study of the tooth-implant supported prostheses indicated that more bone loss was observed with rigid connection. Eventually, they considered that from a clinical perspective, tooth intrusion is a visible phenomenon for the patient, and he/she will complain when this happens, while some more bone lost around the connected implants will not be of concern to the patient. This issue was supported from other studies [17,27—30] who recommended using rigid connection when joining teeth with implants to support FPDs.

The philosophy of treatment concepts; whether to connect implant to natural tooth or not is still a topic of argument, not only because of the differences in the mobilities and other biomechanics of natural teeth and Implants, but also because of different conclusions derived from several clinical and laboratory studies. While totally implant-supported prosthesis was recommended to be the first choice especially in patients with Kennedy class II configuration [10], and some authors did not recommend joining teeth to implants [28,31—33], other published articles concluded that it can be considered as a successful alternative treatment modality [34—37].

Due to these controversial reports, the purpose of this study was to test the null hypothesis that there is no difference in connecting implants to natural teeth and connecting implant to implant to support fixed detachable mandibular partial dentures.

2. Materials & methods

This study was carried out on twenty partially edentulous patients with missing all mandibular molars and bicuspid unilaterally (mandibular class II Kennedy classification). Patient’s general health was evaluated by taking a full medical history as well as special laboratory investigations to ensure that all selected patients were free from any systemic diseases that might have an effect on the implantation process.

Preoperative panoramic and periapical radiographs were made for all patients to show the height of bone in the areas in which implant was to be placed, the position of the mental foramen and inferior alveolar canal, the amount of bone support of the abutment, crestal bone height, the width of periodontal ligament space, continuity of the lamina dura, the presence of periapical lesions, crown/root ratio and root length and form and any clinically undetectable pathology or bone abnormality.

Selected patients were equally divided into two groups (10 each): Group (1): Were with missing all mandibular molars and premolars. Two implants (TSV,
Zimmer Dental Inc, USA) were placed at the mandibular first premolar and first molar areas. A three unit fixed detachable screw retained partial dentures were fabricated to be screwed to the implants after twelve weeks (Fig. 1). Group (2): With missing all mandibular molars and the second premolar, having the mandibular first premolar in a good periodontal health and good bone support. An implant was placed at the mandibular first molar area, preparation of the first premolar was done and a metallic coping was cemented to the tooth with permanent cement (Ketac Cem™, 3M ESPE AG, Germany). A three unit fixed detachable partial denture was fabricated with a telescopic crown cemented to the natural tooth with a provisional cement (TempBond NE, Kerr, CA, USA) and screw retained to the implant after twelve weeks (Fig. 2).

Informed consents were signed from each patient after discussing the treatment plan with them and prior to initiation of treatment. Scheduled visits were performed initiating phase I periodontal therapy for all patients.

Each case was evaluated clinically and radiographically at base line (partial denture insertion), 3, 6 and 12 months after partial denture insertion as follows:

Plaque index [38], probing depth [39], biomechanical complications, periapical and Panoramic X-ray films were used to measure the marginal bone loss around the implants. The long cone paralleling technique using the rinn XCP instrument were used. The marginal bone-level measurements were made from the reference point to the lowest observed point of contact of the marginal bone with the fixture. The reference point for the fixture was the fixture—abutment interface and for the tooth was the margin of the coping. The distance was measured to the nearest 0.01 mm. Only the amount of vertical bone loss was measured.

2.1. Data analysis

All clinical and radiographic data were tabulated for each individual and group. Summary statistics (mean, standard deviation) were calculated and also tabulated for each study group. A repeated-measures two-way analysis of variance (ANOVA) was conducted using R statistical computing language (R Foundation for Statistical Computing, Vienna, Austria). The ANOVA model included effects for treatment group, time and treatment group-time interaction to test the hypothesis.
that no difference exists between the treatment groups over the follow-up period.

For each clinical measure and for the radiographic measure of evaluation, the repeated-measures ANOVA was conducted between the average of the two implants first group and the implant second group.

Statistical assessment of the natural tooth was done separately, where a one-way ANOVA with repeated measures was used to assess the differences during follow up period.

3. Results

3.1. Plaque index

Results in Table 1 and Fig. 3 show no statistically significant difference between treatment groups when comparing the Plaque index for the average of the two implants in group 1 and the implant in group 2 ($P = 0.607$). There was a statistically significant difference in plaque index within a subject across the different time points in the study follow-up period irrespective of the treatment group ($P = 0.0007$). However, the difference in plaque index across study time points (Group*Time) was not statistically significant for the two treatment groups ($P = 0.996$).

Results in Table 2 show a statistically significant difference for plaque index of the tooth in group 2 across different study time points ($P = 0.0287$).

3.2. Probing depth

Results in Table 3 and Fig. 4 show no statistically significant difference between treatment groups when comparing the Probing depth for the average of the two implants in group 1 and the implant in group 2 ($P = 0.645$). There was a statistically significant difference in probing depth within a subject across the different time points in the study follow-up period irrespective of the treatment group ($P < 2\times10^{-16}$). However, the difference in bone level across study time points (Group*Time) was not statistically significant for the two treatment groups ($P = 0.636$).

Results in Table 4 show a statistically significant difference for probing depth of the tooth in group 2 across different study time points ($P = 0.0032$).

3.3. Bone level loss

Results in Table 5 and Fig. 5 show no statistically significant difference between treatment groups when comparing the bone level for the average of the two implants in group 1 and the implant in group 2 ($P = 0.168$). There was a statistically significant difference in bone level within a subject across the different time points in the study follow-up period irrespective of the treatment group ($P < 2\times10^{-16}$). However, the difference in bone level across study time points (Group*Time) was not statistically significant for the two treatment groups ($P = 0.636$).

Results in Table 6 show a statistically significant difference for bone level of the tooth in group 2 across different study time points ($P = 2.3\times10^{-15}$).

3.4. Technical complications

The observation of implant or abutment screw loosening or fracture, natural teeth caries, intrusion,
decementation of telescopic crowns or any other complications revealed nothing except for slight (i.e. less than a quarter turn of screw driver) abutment screw loosening in one case of group two (tooth to implant connection) during the observation period.

4. Discussion

In this study, one tooth is connected to one implant to restore the edentulous span in tooth implant supported fixed partial dentures (TISFPDs) following previous results and recommendations which stated that there is no advantage in connecting more teeth as abutments in TISFPDs [40].

Screw retained prostheses over the implants were selected for use in this study. This procedure was technically more complicated and costly compared to a crown cemented directly on the implants, but was, nevertheless, utilized in the current study because of deficient interarch distances to use cement retained abutments and to allow prostheses retrievability easily [13].

Two types of dental cements were used in the current study. Glass ionomer cement was used to cement the coping to the natural tooth, while temporary luting cement was used to cement the telescopic crown of the 3-unit partial denture to the coping on the natural tooth. The use of glass ionomer cement was supported by previous recommendations that the glass ionomer cement showed the highest marginal accuracy and lowest discrepancies from all other types of cements [41].

A statistically significant decrease in plaque index (PI) of implants in both groups and in tooth in Group 2 (P < 0.05) after the prosthesis has been delivered. Such decrease in PI may be attributed to the proper inclusion and exclusion criteria for patient selection and the stringent oral hygiene regimen implemented after implantation and throughout follow-up visits. This is supported by previous findings [42] that reported successful osseointegrated titanium implants in patients who followed regular oral hygiene instructions in conjunction with meticulous oral examination.

Although (PI) decreased within a subject over the follow-up period of the study, there were no statistically significant differences between Group 1 and Group 2 in all three indices (P > 0.05). The lack of statistical significance between groups and for the Group*Time interaction term (P > 0.05) demonstrates that the oral health of patients was similar in both treatment groups at each study visit and had a similar trend over the study follow-up period. These findings are especially important as they eliminate the confounding effect of potential differences in interpreting results for probing depth and bone level loss.

In this study, there was statistically significant increase within a subject in the probing depth (PD) (P < 0.05) and marginal bone level (BL) (P < 0.05) in both treatment groups and for the natural tooth in Group 2 during the follow-up periods. When

![Fig. 4. Mean probing depth for Group 1 (average of mesial and distal implants) and Group 2 (tooth and implant connected to tooth) across the study time points.](image-url)
comparing Group 1 and Group 2, (PD) and (BL) were similar at each study visit (\(P > 0.05\)) and had a similar trend over the study follow-up period for both groups (Group*Time \(P > 0.05\)). The change within a subject during the study follow-up period could be attributed to bone resorption during the first year after implant placement. Observed changes are consistent with current knowledge of acceptable clinical values for bone loss post implant placement as reported previously [43,44]. The small increase in (PD) and (BL) may also be due to the strict oral hygiene regimen that was implemented for patients in the present study [45]. These changes may also be attributed to the canine guidance occlusion that lowered the loads on the opposing implant supported dentures, thus minimized probing depth [46].

In the present study, the amount of marginal bone level loss at the end of follow up period was (0.73 mm) around implants connected to teeth, (0.71 mm) around implants splinted together and (1.54 mm) around teeth. Although there was radiographically more bone lost around implant connected to teeth than implants connected together; this was not statistically significant, these findings agree with results reported in other studies after follow up period [47–49]. Also; in a previous study; a bone loss of 0.96 mm adjacent to mandibular implants was observed during the first year [25].

In this study, no adverse biomechanical outcomes were observed including implant or abutment screw loosening or fracture, natural teeth caries, intrusion, decementation of telescopic crowns or any other complications were not noticed except for slight (less than a quarter turn of screw driver) abutment screw loosening in one case of group two (tooth to implant connection) during the observation period, which agrees with findings of previous studies [48,50]. This was resolved by retightening the screws.

In the current study, bone loss was considered as the most important variable. There were no differences for implants rigidly attached to natural teeth and implants attached to other implants supporting partial dentures. For all analyses, both groups were comparable. The amount of crestal bone level changes was within the criteria for implant success suggested by Albrektsson et al. [47]. Thus, it could be concluded that connecting implants to teeth, using rigid connection to support partial denture, as demonstrated in the current study, is a viable method that is suitable for implementation in dental practice.

5. Conclusions

Based on the limitation of the results of the present study, it was concluded that:-

- The implant-supported prosthesis is well documented as the optimal treatment modality in partially edentulous patients and will remain the primary therapy of choice when conditions allow.
- The tooth-implant supported prosthesis, however, is an equal predictable treatment as the implant-supported prosthesis concerning implant survival and loss of marginal bone in the short term evaluation.

Conflict of interest

The Authors declare that they have no conflict of interest, have full control of all primary data.

References

[1] Bergman B, Hugoson A, Olsson C. A 25 year longitudinal study of patients treated with removable partial dentures. J Oral Rehabil 1995;22:595–9.
[2] Bergman B, Hugoson A, Olsson C. Caries, periodontal and prosthetic findings in patients with removable partial dentures: a ten-year longitudinal study. J Prosthet Dent 1982;48:506–14.
[3] Kapur KK. Veterans Administration Cooperative Dental Implant Study — comparisons between fixed partial dentures supported by blade-vent implants and removable partial dentures. Part IV: comparisons of patient satisfaction between two treatment modalities. J Prosthet Dent 1991;66:517–30.
[4] Zlatevic D, Celebic A, Valentic-Peuzovic M. The effect of removable partial dentures on periodontal health of abutment and non-abutment teeth. J Periodontol 2002;73:137–44.

[5] Budtz-Jorgensen E, Isidor F. A 5-year longitudinal study of cantilevered fixed partial dentures compared with removable partial dentures in a geriatric population. J Prosthet Dent 1990;64:42–7.

[6] Glantz PO, Nilner K, Jendresen MD, Sundberg H. Quality of fixed prosthodontics after 15 years. Acta Odontol Scand 1993;51:247–52.

[7] Toolson L, Taylor T. A 10-year report of longitudinal recall of overdenture patients. J Prosthet Dent 1989;62:179–81.

[8] Zitzmann NU, Marinello CP. A review of clinical and technical considerations for fixed and removable implant prostheses in the edentulous mandible. Int J Prosthodont 2002;15:65–72.

[9] Garcia LT, Oesterle LJ. Natural tooth intrusion phenomenon with implants: a survey. Int J Oral Maxillofac Implants 1998;13:227–31.

[10] Dalkiz M, Zor M, Akyul H, Toparli M, Aksoy S. The three-dimensional finite element analysis of fixed bridge restoration supported by the combination of teeth and osseointegrated implants. Implant Dent 2002;11:293–300.

[11] Marder M, Marder R. An accurate, single, platform-level impression technique for the fabrication of prosthetic restorations on dental implants. Int J Periodontics Restorative Dent 2005;25:495–9.

[12] Lauffer BZ, Gross M. Splinting osseointegrated implants and natural teeth in rehabilitation of partially edentulous patients. Part II: principles and applications. J Oral Rehabil 1998;25:69–80.

[13] Kindberg H, Gunne J, Kronstrom M. Tooth- and implant-supported prostheses: a retrospective clinical follow-up up to 8 Years. Int J Prosthodont 2001;14:575–81.

[14] Cordaro L, Ercoli C, Rossini C, Torsello F, Feng C. Retrospective evaluation of complete-arch fixed partial dentures connecting teeth and implant abutments in patients with normal and reduced periodontal support. J Prosthet Dent 2005;94:313–20.

[15] Chee W, Mordhahi N. Tooth-to-implant connection: a systematic review of the literature and a case report utilizing a new connection design. Clin Implant Dent Relat Res 2010;12:122–33.

[16] Bragger U, Aeschlimann S, Burgin W, Hammerle C, Lang NP. Biological and technical complications and failures with fixed partial dentures (FPD) on implants and teeth after four to five years of function. Clin Oral Implants Res 2001;12:26–34.

[17] Lang NP, Pjetursson BE, Tan K, Bragger U, Egger M, Zwahlen M. A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation period of at least 5 years. Int J Combined tooth-implant-supported FPDs. Clin Oral Implants Res 2004;15:643–53.

[18] Lekholm U, Gunne J, Henry P. Survival of the Branemark implant in partially edentulous jaws: a 10-year prospective multicenter study. Int J Oral Maxillofac Implants 1999;14:639–45.

[19] Nickenig H, Spiickermann H, Wichmann M, Andeas S, Eitter S. Survival and complication rates of combined tooth-implant-supported fixed and removable partial dentures. Int J Prosthodont 2008;21:131–7.

[20] Cho GC, Chee WW. Apparent intrusion of natural teeth under an implant supported prosthetic: a clinical report. J Prosthet Dent 1992;68:3–5.

[21] Kayacan R, Ballarini R, Mullen R. Theoretical study of the effect of tooth and implant mobility differences on occlusal force transmission in tooth/implant supported partial prostheses. J Prosthet Dent 1997;78:391–9.

[22] Hata Y, Watanabe F, Fukuda H, Hamamura T, Nisyama K. Stress analysis of intermobile element by three dimensional finite element [abstract 69]. J Dent Res 1996;69:117.

[23] Holmes DC, Haganman CR, Aquilino SA. Deflection of superstructure and stress concentrations in the IMZ implant system. Int J Prosthodont 1994;7:239–46.

[24] Uysal H, Ilipiccioglu H, Avci M, Bilir OG, Kurul O. Efficacy of the intramobile connector in implant tooth-supported fixed prostheses: an experimental stress analysis. Int J Prosthodont 1999;12:355–61.

[25] Naert I, Quirynen M, Van Steenbergh DE, Darius P. A six-year prosthodontic study of 509 consecutively inserted implants for the treatment of partial edentulism. J Prosthet Dent 1992;67:236–45.

[26] Naert I, Duyck JA, Hosny MM, Quirynen M, Van Steenbergh DE. Freestanding and tooth-implant connected prostheses in the treatment of partially edentulous patients Part II: an up to 15-years radiographic evaluation. Clin Oral Implants Res 2001;12:245–51.

[27] Block M, Lirette D, Gardiner D, Li L, Finger IM, Hochstedler J, et al. Prospective evaluation of implants connected to teeth. Int J Maxillofac Implants 2002;17:473–87.

[28] Carrillo C, Hernández-Aliaja M, Calvo-Guirado J. Tooth-implant connection: a bibliographic review. Med Oral Patol Oral Cir Bucal 2010;15:387–94.

[29] Hoffmann O, Zafripoulos G. The tooth-implant connection: a review. J Oral Implantol 2012;38:194–200.

[30] Mamalis A, Markopoulou K, Kaloumenos C, Analitis A. Splinting osseointegrated implants and natural teeth in partially edentulous patients: a systematic review of the literature and a case report. J Oral Implantol 2012;12:67–80.

[31] Naveau A, Pierrinsard L. Mechanical effects of implant-tooth rigid connection by a fixed partial denture: a 3-d finite element analysis. Eur J Prosthodont Restor Dent 2009;17:98–104.

[32] Greenstein G, Cavallaro J, Smith R, Tarnow D. Connecting teeth to implants: a critical review of the literature and presentation of practical guidelines. Compend Contin Educ Dent 2009;30:440–53.

[33] Spyropoulou P, Razzaog M, Chronaidos D. Nonrigid connection of tooth with implants in the esthetic zone with a ceramic restoration: a clinical report. J Prosthet Dent 2011;106:214–8.

[34] Biancu S, Ericsson I, Lindhe J. The periodontal ligaments of teeth connected to osseointegrated implants. J Clin Periodontol 1995;22:362–70.

[35] Tangerud T, Gronningsaeter A, Taylor A. Fixed partial dentures supported by natural teeth and Branemark system implants: a 3-year report. Int J Oral Maxillofac Implants 2002;17:212–9.

[36] Palmer R, Howe L, Palmer P. A prospective 3-year study of fixed bridges linking Astra Tech ST implants to natural teeth. Clin Oral Implants Res 2005;16:302–7.

[37] Wollke B, Sailer I, Thoma A, Menghini G, Hammerle C. Clinical and radiographic evaluation of patients receiving both tooth- and implant-supported prosthodontic treatment after 5 years of function. Int J Prosthodont 2012;25:252–9.

[38] Mombelli A, Lang N. Clinical parameters for the evaluation of dental implants. Periodontol 2000 1994;4:81–6.

[39] Akagawa Y, Matsamoto T, Hashimoto M, Tsuru H. Clinical evaluation of the gingival around single crystal sapphire osseous implant after experimental ligature induced plaque accumulation in monkeys. J Prosthet Dent 1992;68:111–8.
Zhiyong L, Arataki T, Shimamura I, Kishi M. The influence of prosthesis designs and loading conditions on the stress distribution of tooth-implant supported prostheses. Bull Tokyo Dent Coll 2004;45:213–21.

Boeckler A, Morton D, Kraemer S, Gerstdorfer J, Setz J. Marginal accuracy of combined tooth–implant-supported fixed dental prostheses after in vitro stress simulation. Clin Oral Implants Res 2008;19:1261–9.

Leonhardt A, Dahlen G, Renvert S. Five-year clinical, microbiological, and radiographical outcome following treatment of peri-implantitis in man. J Periodontol 2003;74:1415–22.

Visser A, Gerr M, Henny J. Mandibular overdentures supported by two or four endosseous implants: a 5-years prospective study. Clin Oral Implants Res 2005;16:19–25.

Turkyilmaz I. Clinical and radiological results of patients treated with two loading protocols for mandibular overdentures on Branemark implants. J Clin Periodontol 2006;33:233–8.

Henny J, Gerry M, Martin A. Comparison of implant retained mandibular overdentures and conventional complete dentures: A 10-year prospective study of clinical aspects and patient satisfaction. Int J Oral Maxillofac Implants 2003;18:879–85.

Narhi T, Hevinga M, Kalk W. Maxillary overdentures retained by splinted and unsplinted implants: a retrospective study. Int J Oral Maxillofac Implants 2001;16:259–66.

Eriksson I, Lekholm U, Bränenmark P-I, Lindhe J, Glantz P-O, Nyman S. A clinical evaluation of fixed bridge restorations supported by the combination of teeth and osseointegrated titanium implants. J Clin Periodontol 1986;13:307–12.

Gunne J, Åstrand P, Lindh T, Borg K, Olsson M. Tooth-implant and implant supported fixed partial dentures. A 10-year report. Int J Prosthodont 1999;12:216–21.

Hosny M, Duyck J, Steenberghé D, Naert I. Within-subject comparison between connected and non-connected tooth-to-implant fixed partial prostheses: up to 14-year follow-up study. Int J Prosthodont 2000;13:340–6.

Olsson M, Gunne J, Åstrand P, Borg K. Bridges supported by freestanding implants versus bridges supported by tooth and implant. A five-year prospective study. Clin Oral Implants Res 1995;6:114–21.