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Comparative study of two different designs of partial over denture supported with distal implant for the treatment of mandibular Kennedy class II cases

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Abstract

The objective of the present study was to compare between two mandibular implant overdentures of class II Kennedy classification. Material and methods: Fourteen male patients (30–45 years) were selected and divided into two equal groups. Group I received a mandibular removable partial over denture retained with implant abutment at the first molar region and with extra coronal attachment to the first premolar. Cross arch stabilization was made by using double Aker clasp on the first and second molars of the opposite side. Group II received a unilateral mandibular removable partial over denture retained with implant abutment at the first molar region and with extra coronal attachment to a splinted first premolar and canine. Patient satisfaction, clinical and radiographic evaluations were carried out at regular recall appointments up to one year from implant loading. Results: There was insignificant increase in the pocket depth and gingival recession and insignificant decrease in the perio test values and plaque index around implants and abutments. There was insignificant increase in the marginal bone loss around implants and abutments in both groups. All patients strongly disagreed the high cost of the treatment. Group II patients were more satisfied regarding aspects of the patients' comfort and phonetics. Conclusion: It is concluded that unilateral removable partial denture was more comfortable and better with speech. The use of dental implant as a distal abutment in class II Kennedy classification reduces all the movements of denture base and results in better healthy condition for the gingival and periodontium of the abutment tooth than when using conventional partial denture.

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Open access under [CC BY-NC-SA license](https://creativecommons.org/licenses/by-nc-sa/4.0/).*Keywords:* Partial over denture; Implant; Mandibular

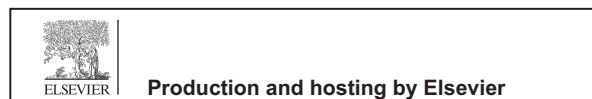
1. Introduction

Removable partial denture (RPD) continues to be an essential prosthetic consideration in many oral reconstructions, especially when edentulous ridges posterior to a patient's remaining teeth are to be restored [1]. Rehabilitation of a partially edentulous patient can be established using a wide range of prosthetic treatment options including simple conventional removable partial denture, over denture, fixed partial denture or dental implants [2].

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For patients with unilateral edentulism in molar region, removable partial dentures with a unilaterally designed framework claimed to be more comfortable during mastication and speech, and more profound effect is anticipated on patients' acceptance due to its relative simplicity. However, clinical use of the unilaterally designed framework is criticized owing to the poor retention and stability compared with the removable partial denture with bilaterally designed framework [3].

Most of these problems could be attributed to the absence of the posterior abutment [4]. Since, the difference in displacement between the mucosa and the periodontal ligament of last standing abutment was estimated to be up to 25 times [5]. Consequently, when functional pressure is applied to the distal extension base removable partial denture, the resultant forces are extremely damaging to the abutment teeth and must be controlled if clinical treatment is to be successful [6].

The use of dental implant as a distal abutment can convert a distal extension removable partial denture from a tooth- and tissue-supported prosthesis to a tooth- and implant- supported and retained prosthesis. A posterior placed implant provides a definite stop and stability and eliminates the problems often associated with a tooth- and tissue-supported distal extension removable partial denture [7].

Splinting of abutments is required for teeth that are proposed to support and retain distal extension bases, especially if these teeth are weak or if suspected to carry loads beyond their physiologic limits. Splinting is also required when precision attachments or implants are included in the design of distal extension base [8].

2. Aim of the study

The purpose of this study was to compare between two different designs for the treatment of mandibular class II Kennedy classification supported with distal implant according to patient satisfaction, clinical evaluation and radiographic evaluation.

3. Material and methods

Fourteen male patients were selected for this study with their age ranging from 30 to 45 years. They had mandibular class II (Kennedy classification) with missing second premolar and molars and with almost intact opposing natural teeth. The patients were divided into two groups. Each group consists of seven patients. Group I received a mandibular removable partial over denture retained with O-ring attachment to the posterior screw retained ball attachment implant

abutment and with a resilient extra coronal attachment to the first premolar. Cross arch stabilization was made on the opposite side by using double Aker clasp on the first and second molars joined to the saddle by lingual plate. Group II received a unilateral mandibular removable partial over denture retained with O-ring attachment to the posterior screw retained ball attachment implant abutment and with a resilient extra coronal attachment to a splinted first premolar and canine.

The maximum bone height of the alveolar ridge was not less than 10 mm and the labiolingual width of the alveolar ridge at the prospective implant site is not less than 6 mm according to the ridge mapping process. The area under investigation was given local anesthesia and the thickness of the soft tissue was measured by puncturing it to the bone using a graduated periodontal probe. The information was transferred to a cast of the jaw which was sectioned through the ridge [9].

Each patient received osteoCare™ Maxi Z implant of 13 mm length and 3.75 mm diameter in the first molar region of the mandible using flapless implant surgery and left 3 months for osseointegration before the abutment connection.

- Construction of the fixed restoration with extra coronal attachment on the abutments:

The mandibular first premolar on the saddle side for group [1] patients, while the mandibular first premolar and canine on the saddle side for group [2] patients were prepared to receive full covered porcelain metal crowns with resilient extra coronal attachment on distal surface.

- Construction of the partial denture: [Figs. 1 and 2](#)

Maxillary and mandibular preliminary impressions were made and poured to obtain study casts on which custom-made trays were fabricated. The casts were



Fig. 1. The finished denture for group I and group II patients respectively.



Fig. 2. The finished denture for group I and group II patients respectively.

surveyed by using Ney dental surveyor. Mouth preparations were done in the patient mouth including elimination of undesirable undercuts, preparation of the proximal tooth surface to provide guiding planes and preparation of the occlusal rest seats on the occlusal surface of the first and second molars and cingulum rest seats on the mandibular canines for patients of group [1]. Secondary impressions were made and poured to produce the master cast which mounted on the surveying table at the same selected path of insertion. A tissue stop was made at the distal end of the relief wax and tripodding of the master cast was done. Duplication of the master cast was done to produce the refractory cast on which the wax pattern of the metal framework was fabricated, invested, burned out and casted in cobalt chromium alloy. The produced metallic framework was finished, polished and tried in the patient's mouth.

The centric occluding relation was registered and a face bow record was utilized to mount the maxillary cast. The lower master cast with the metallic framework and the occlusal wax rim was mounted with the upper cast on Hanau model H2 articulator according to

the registered centric occluding relation. A protrusive record was then taken and the horizontal condylar angle of the articulator was adjusted and the lateral condylar angle is obtained from the following formula: $L = H/8 + 12$ Where L is the lateral condylar angle and H is the horizontal condylar angle.

Semianatomic acrylic teeth were arranged in balanced occlusion and tried in the patient's mouth. The waxed up denture was processed. Checking of stability, retention, occlusion, speech and patient's comfort was performed.

After three months, the osseointegration around dental implant had been formed and the insertion of the partial over denture could be made. The titanium cover screw was unthreaded and the ball abutment was screwed. Final cementation of abutment porcelain crowns with male portion of attachment was made with glass ionomer cement. Figs. 3 and 4

Relief was made in the fitting surface of the denture base, one at the side of the implant ball and the other at the side of the extra coronal attachment ball. The polycarbonate housing with rubber O-ring of dental implant and metallic housing of the extra coronal attachment were placed on the implant ball and the extra coronal attachment ball respectively and making sure that they were securely seated.

The pressure indicating paste was applied to the fitting surface of the denture base in the areas of the polycarbonate housing with rubber O-ring of dental implant and metallic housing of the extra coronal attachment then seated in the patient's mouth. Using slight pressure, the positions of the polycarbonate housing with rubber O-ring of dental implant and metallic housing of the extra coronal attachment were imprinted in the paste. When the areas had been located, there were hollowed out. This procedure was repeated until the denture seats to the proper position.



Fig. 3. The porcelain crowns with a (ball type) male profile OT cap extra coronal attachment on its distal surface were cemented in the patient mouth for group I and group II patients respectively.



Fig. 4. The porcelain crowns with a (ball type) male profile OT cap extra coronal attachment on its distal surface were cemented in the patient mouth for group I and group II patients respectively.

- Pick-up of the Housing (chair-side pick-up procedures)
 - The relieved areas of the denture base were filled with self-cured acrylic resin and place the denture over the housings.
 - The patient instructed to bite gently on the denture to confirm correct seating, whilst the acrylic was set.
 - The denture was removed and the security of the housings inside the denture was assessed. Any excess of the self-cured acrylic resin was removed and the denture was trimmed and polished. [Figs. 5 and 6](#)
 - The denture was re-inserted and tried in the patient's mouth; occlusion was checked and verified in centric and eccentric occlusion.
- Patient satisfaction, clinical and radiographic evaluations were carried out for every patient at denture insertion, 3, 6 & 12 months after insertion.

Informed consent was signed at the beginning of the research as a main step to continue the study. Each patient was informed to fill out a satisfactory questionnaire to be collected at the end of the study regarding the cost, comfort, esthetics, ability to eat, gum shape and color (gingival health), food impaction, phonetics, prosthesis loosening and general satisfaction [10].

The clinical evaluation was performed regarding implant and tooth stability with the periost [11], gingival recession, pocket depth [12] and plaque index [13].

Radiographic evaluation was performed [14]. Digital Panoramic X-ray films were used to measure the

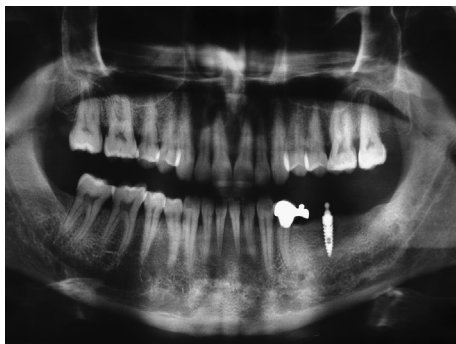


Fig. 5. Postoperative panoramic X-ray was made for every patient showing the posterior screw retained ball attachment implant abutment and a resilient extra coronal attachment to the first premolar for group I and to a splinted first premolar and canine for group II patients respectively.

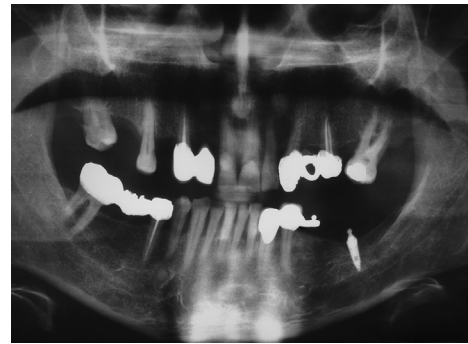


Fig. 6. Postoperative panoramic X-ray was made for every patient showing the posterior screw retained ball attachment implant abutment and a resilient extra coronal attachment to the first premolar for group I and to a splinted first premolar and canine for group II patients respectively.

marginal bone loss around the implant and abutments. The marginal bone loss was measured on the lateral aspect of the implant and abutments in 1:1 magnification mode using image measurement program (*m-viewTM*, Marotech, Seoul, Korea).

The collected data was organized, tabulated and statistically analyzed using SPSS software statistical computer package version 19. For categorical data, the number and percentage were calculated. For numerical data, the mean and standard deviation were calculated. Comparison of categorical data between studied groups was performed using Mann–Whitney test. The difference between means between groups was statistically analyzed using the unpaired students (*t*) test. Significance was adopted at $p < 0.05$ for interpretation of results of tests of significance [15].

4. Results

4.1. The patient satisfaction

All patients responded for the treatment with high satisfaction. Patients of group I and group II strongly disagreed the high cost of the treatment. Group II patients were more satisfied of the treatment regarding aspects of the patients' comfort and phonetics. No significant difference in aspects of esthetics, ability to eat, prosthesis loosening, gingival health and food impaction between the two groups were found.

[Table 1:](#)

4.2. Clinical evaluation in [Tables 2–6](#)

In [Tables 2 and 3](#), all the perio test values (PTVs) of the implant and tooth in both groups through the

Table 1
Shows the comparison of the patient satisfaction between the two groups.

Patient satisfaction	Group I (n = 7)		Group II (n = 7)		Z	p
	n	%	n	%		
Patients' comfort:					2.235	0.025*
Neutral	4	57.1	0	0.0		
Agree	2	28.6	3	42.9		
Strongly agree	1	14.3	4	57.1		
Esthetics:					1.545	0.122
Agree	5	71.4	2	28.6		
Strongly agree	2	28.6	5	71.4		
Ability to eat:					0.515	0.606
Agree	3	42.9	4	57.1		
Strongly agree	4	57.1	3	42.9		
Gingival health:					0.000	1.000
Agree	4	57.1	4	57.1		
Strongly agree	3	42.9	3	42.9		
Food impaction:					1.421	0.125
Agree	4	57.1	3	42.9		
Strongly agree	3	42.9	4	57.1		
Phonetics:					2.912	0.004*
Neutral	4	57.1	0	0.0		
Agree	3	42.9	2	28.6		
Strongly agree	0	0.0	5	71.4		
Prosthesis loosening:					0.000	1.000
Agree	2	28.6	2	28.6		
Strongly agree	5	71.4	5	71.4		
General satisfaction:					1.041	0.298
Agree	5	71.4	3	42.9		
Strongly agree	2	28.6	4	57.1		

*Significant at $p > 0.05$.

follow-up period were negative. There was insignificant decrease in the perio test values (PTVs) of the implant and tooth in both groups through the follow-up period.

Concerning Tables 4 and 5, there was insignificant increase in the gingival recession in both groups after the first 3 months of prosthesis insertion, also for the pocket depth around implants and abutments in both groups through the follow-up period.

However, Table 6 shows non-significant decrease in plaque index in both groups through the follow-up period.

4.3. Radiographic evaluation

Table 7 shows the marginal bone loss for group I and group II. Insignificant increase in the marginal bone loss was found between the two groups.

Table 2
shows the comparison of the perio test evaluation for implant stability at different periods of follow up between the two groups.

Period of follow up	Perio test evaluation for implant stability		t	p
	Group I	Group II		
At insertion:				
Mean ± S.D.	-1.57 ± 0.53	-1.28 ± 0.48	-1.04	0.318
After 3 months:				
Mean ± S.D.	-2.28 ± 0.48	-2.14 ± 0.37	-0.61	0.553
After 6 months:				
Mean ± S.D.	-2.71 ± 0.46	-2.57 ± 0.33	-0.52	0.612
After 12 months:				
Mean ± S.D.	-3.71 ± 0.44	-3.57 ± 0.29	-0.65	0.717

*Significant at $p > 0.05$.

Table 3

Shows the comparison of the perio test evaluation for tooth stability at different periods of follow up between the two groups.

Period of follow up	Perio test evaluation for tooth stability		<i>t</i>	<i>p</i>
	Group I	Group II		
At insertion:				
Mean ± S.D.	-1.28 ± 0.48	-1.57 ± 0.53	1.04	0.318
After 3 months:				
Mean ± S.D.	-2.14 ± 0.37	-2.57 ± 0.51	1.73	0.109
After 6 months:				
Mean ± S.D.	-2.28 ± 0.29	-2.71 ± 0.48	1.64	0.126
After 12 months:				
Mean ± S.D.	-3.28 ± 0.21	-3.71 ± 0.39	1.69	0.135

*Significant at $p > 0.05$.

5. Discussion

Removable partial dentures (RPDs) are considered for rehabilitation of partially edentulous dental arch, restoring efficient function and ensuring patient's comfort with long term maintenance and stability [16]. The clinical use of the removable partial denture with a unilaterally designed framework is criticized owing to the poor retention and stability compared with the removable partial denture with a bilaterally designed framework [7]. Mandibular implant assisted removable partial denture treatment has significantly increased the scores for retention and stability of the denture, masticatory function and general denture satisfaction. Furthermore, it may have favorable psychological and social effects on the patient [6,17,18].

In this study fourteen male patients with mandibular class II (Kennedy classification) with missing second premolar and molars were selected and their age ranging from 30 to 45 years.

In this study a mandibular removable partial over denture was constructed and retained with O-ring attachment to the posterior screw retained ball

attachment implant abutment and with a resilient extra coronal attachment to the first premolar, cross arch stabilization was made on the opposite side by using double Aker clasp on the first and second molars joined to the saddle by lingual plate for each patient of group I, while for each patient of group II a unilateral mandibular removable partial over denture was constructed and retained with O-ring attachment to the posterior screw retained ball attachment implant abutment and with a resilient extra coronal attachment to a splinted first premolar and canine.

The use of a removable prosthesis permits the patient to remove the restoration at night to reduce nocturnal parafunctional forces and reduce the stresses on the implant and abutments, also prevent food impaction beneath the denture which can be removed by the patient to clean it and reinserted again without dentist help [19].

In this study, the dental implant was placed posteriorly in the first molar region as this position has been suggested for stabilization and carrying the retentive elements for removable partial over denture and allow the use of a suitable implant length with a safety

Table 4

Comparison of the gingival recession at different periods of follow up between the two groups.

Period of follow up	Gingival recession		<i>t</i>	<i>p</i>
	Group I	Group II		
At insertion:				
Mean ± S.D.	2.57 ± 0.18	2.64 ± 0.18	0.37	0.714
After 3 months:				
Mean ± S.D.	3.04 ± 0.20	3.11 ± 0.24	1.2	0.240
After 6 months:				
Mean ± S.D.	3.14 ± 0.22	3.21 ± 0.36	1.27	0.215
After 12 months:				
Mean ± S.D.	3.41 ± 0.47	3.56 ± 0.51	1.71	0.099

*Significant at $p > 0.05$.

Table 5

Comparison of the pocket depth at different periods of follow up between the two groups.

Period of follow up	Pocket depth		<i>t</i>	<i>p</i>
	Group I	Group II		
At insertion:			0.000	1.000
Mean ± S.D.	1 ± 0.0	1 ± 0.0		
After 3 months:				
Mean ± S.D.	1.35 ± 0.32	1.46 ± 0.42	0.76	0.454
After 6 months:				
Mean ± S.D.	1.71 ± 0.39	1.95 ± 0.56	1.27	0.215
After 12 months:				
Mean ± S.D.	1.9 ± 0.41	1.99 ± 0.59	0.635	0.553

*Significant at $p > 0.05$.

Table 6
Comparison of the plaque index at different periods of follow up between the two groups.

Period of follow up	Plaque index		<i>t</i>	<i>p</i>
	Group I	Group II		
At insertion:				
Mean ± S.D.	2.05 ± 0.28	1.92 ± 0.27	1.21	0.237
After 3 months:				
Mean ± S.D.	1.67 ± 0.24	1.58 ± 0.21	0.94	0.355
After 6 months:				
Mean ± S.D.	1.30 ± 0.21	1.17 ± 0.19	1.54	0.135
After 12 months:				
Mean ± S.D.	0.62 ± 0.15	0.51 ± 0.13	1.43	0.164

*Significant at $p > 0.05$.

margin of at least 2 mm above the mandibular canal [20,21].

OsteoCare™ Maxi Z two-piece (Ball type) implant with diameter of 3.75 mm and length of 13 mm with an O-Ball head was selected for this study.

Patient satisfaction, clinical and radiographic evaluations were carried out for every patient at denture insertion, 3, 6 & 12 months after insertion.

Although all patients responded to most of the statements with high satisfaction, patients of group I and group II strongly disagree the high cost of the treatment and these results are in agreement with Pjetursson et al. [22] who reported in his study that the costs associated with implant therapy in Switzerland were considered to be justified, while Tepper et al. [23] described the implant supported rehabilitation to be very expensive in Austria.

There was a significant difference in the patients' comfort and phonetics between the two groups, which might be attributed to the relative simplicity, smaller size and absence of the lingual plate major connector with the unilaterally designed mandibular removable partial over denture of group II patients [1,24].

Table 7
Comparison of the marginal bone loss at different periods of follow up between the two groups.

Period of follow up	Marginal bone loss		<i>t</i>	<i>p</i>
	Group I	Group II		
At insertion:				
Mean ± S.D.	0.36 ± 0.23	0.55 ± 0.30	1.58	0.126
After 3 months:				
Mean ± S.D.	0.68 ± 0.25	0.85 ± 0.32	1.59	0.123
After 6 months:				
Mean ± S.D.	0.81 ± 0.28	1 ± 0.34	1.4	0.173
After 12 months:				
Mean ± S.D.	1.22 ± 0.30	1.35 ± 0.36	1.16	0.256

*Significant at $p > 0.05$.

There was no significant difference in esthetics between the two groups, this may be due to the use full covered porcelain metal crown with an extra coronal attachment which preclude the need for conventional clasping and optimize esthetics [6].

According to the ability to eat and prosthesis loosening, no significant difference was found. This may be due to the improved retention and stability of the mandibular partial over denture in both groups due to the use of an extra coronal attachment which improves retention and stability and also the efficiency of retention are not affected by the contour of the abutment teeth [25–27].

There was no significant difference in the gingival health and food impaction between two groups which might be attributed to the use of an extra coronal attachment and distal implant which improve retention and stability of the prosthesis resulting in better healthy condition for the gingival and periodontium of the abutment tooth [4,28]. Also, the removable prosthesis can be removed by the patient to clean it and reinserted again without dentist help preventing food impaction beneath the denture and improving the gingival health [19].

The patients were followed-up for one year, as the maximum bone changes occur mostly during the first year after loading [29,30].

All the fourteen fixtures were successfully osseointegrated all over the follow-up period, that there is no mobility, no pain and radiographically, the fixtures were surrounded by normal bone tissue in intimate contact with their surfaces.

Insignificant decrease in the perio test values (PTVs) of the implant and tooth in both groups through the follow-up period. These results are in agreement with Van Steenberghe et al. [31] who reported a progressive decrease in PTVs over time due to the increased mineralized bone-to-implant contact with increasing implant function. Also, a progressive increase of the torque force required to remove the implants after insertion associated with a progressive decrease in PTVs over time was reported and the osseointegration process continued also after the first year of function [32].

Slight insignificant increase in the gingival recession was found in both groups after the first 3 months of prosthesis insertion, this may be due to gingival shrinkage during healing after surgery. These results are in agreement with Abu Elross [33] who suggested that the increasing in the gingival recession with time may be aggravated by movement of the denture base during function which may exert pumping action of the

gingival margin. Such recession was decreased after relief in acrylic resin of the over denture over the inflamed gingival tissue.

In this study, there was insignificant increase of the pocket depth around implants and abutments in both groups through the follow-up period. These results are in agreement with Eugenio et al. [34] and Gerber et al. [35] as they found an increase in pocket depth in one year follow-up period. Still the maximum pocket depth 1.9 mm in group I and 1.99 mm in group II with a raise of 0.9 mm and 0.99 mm for group I and group II respectively in the end of follow up period, falls within the physiologic range. This might be due to maintenance of oral hygiene, which is in agreement with Mekkawy [36] and to the balanced occlusion that minimized the loads on the opposing implant retained over denture and thus minimized pocket depth and loss of epithelial attachment [37].

The current non-significant decrease in plaque index in both groups might be attributed to the routine hygienic procedures by which the health of the gingival margin is normally maintained and would seem to be adequate after the prosthesis has been fitted, or in other words, the patients maintain a high level of oral hygiene [38].

In this study, crestal bone resorption related to implant abutments in both groups after one year follow-up did not exceed 1 mm, hence all implants were considered successful [39].

The result of this study were in agreement with the studies of Piao et al. [40] who found that the radiographic annual bone loss around fixtures in the lower jaw was 0.8 mm for the first year and less than 0.1 mm for the following years. Moreover, the mean bone loss of the posterior implants for distal extension removable partial denture was less than 1 mm after functional loading [41].

6. Conclusion

From this study it can be concluded that:

- Removable partial denture with a unilaterally designed framework in class II Kennedy classification cases is more comfortable, better with speech and more profound effect is anticipated on patients' acceptance due to its relative simplicity.
- Distal implant with a resilient frictional abutment complex (the abutment with extra coronal attachment) retentively provides stability and eliminates the problems often associated with a tooth and tissue supported RPD by converting distal

extension RPD base from a tooth and tissue-supported prosthesis to a tooth and implant supported and retained prosthesis and so the extension of the RPD can be reduced.

- Splinting is required for teeth that are proposed to support and retain distal extension bases, especially if these teeth are weak or if suspected to carry loads beyond their physiologic limits. Splinting is also required when precision attachments or implants are included in the design of distal extension base.
- In comparing with fixed restoration, unilateral mandibular removable partial over denture was easily removed and replaced by the patient, so it was hygienic and easily cleaned. Also, removal of the restoration at night reduces nocturnal parafunctional forces and reduce the stresses on the implant and abutments.

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