Official Journal Issued by Faculty of Veterinary Medicine

Benha Veterinary Medical Journal

Journal homepage: https://bvmj.journals.ekb.eg/

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Original Paper

Development of a technique for interseptal immediate dental implantation and titanium crown restoration in dogs: Experimental studies

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ARTICLE INFO

Keywords

Development

Technique

Immediate - Interseptal

Dental- Implants

Dogs

Received 27/05/2023
Accepted 23/06/2023

Available On-Line:
01/07/2023

ABSTRACT

Dental implants are implant fixtures that replace the missing teeth, and inserted into the underlying bone to support the prosthesis. The aim of the present study is the development of a suitable technique for interseptal immediate dental implant placement in dogs, the identification of an exact location that is suited for the implants, and the demonstration of the step-by step clinical procedure. Six dental implants of (SLA) type were used in this study. Two pieces of titanium dental implants were implanted in three adult healthy dogs (one implant for each side) in the lower jaw. The implants were placed in two groups, group (A) without using of alendronate, and group (B) using alendronate. To describe the developed technique for interseptal immediate implantation in these dogs, the suitability, the stability, and the clinical effects were recorded just before the procedure, and after the implantation at zero day, 30, 60 and 90 days. At the 90thday, tooth impressions were taken on the abutment of the implant for restoration of the extracted crown by titanium crown. The technique developed for immediate interseptal implant in this study was anatomically feasible, no blood vessels or nerves in the course of the pilot-drill, and subsequently the implant. The implants in group (A) were more stable than those in group (B). All the implants of group (A) were successfully fixed in place, while those of group (B) were failed. In conclusion, the use of interseptal immediate dental implant placement was suitable, feasible and accessible in dogs.

1. INTRODUCTION

As a crucial part of traditional dentistry, dental implantology has cemented its position (Kalaivani et al., 2020). Implants are occasionally used as a practical alternative to conventional treatment options for the rehabilitation of significant functional, anatomical, or aesthetic issues brought on by tooth loss (Qassadi et al., 2018). In order to save bone and speed up recovery, more and more patients are selecting immediate implants following extraction. By conserving the soft tissues, immediate implant placement enhances aesthetics as well (Dhamiet al., 2019).

Dental implants are surgical parts that are inserted into the jawbone or skull to support dental prostheses such crowns, bridges, dentures, facial prosthesis, or anchors for braces (John et al., 2007). The biological mechanism of osseointegration, in which materials like titanium form a close bond with bone, provides the basis for modern dental implants (Parithimarkalaignanand Padmanabhan, 2013). After the implant fixture has been put in place, a dental prosthetic is applied to make it more likely for it to osseointegrate (Smeets et al., 2016). Prior to the implant being connected to the dental prosthesis an abutment is put in place that will hold a dental prosthetic, osseointegration may need to heal for a varying period of time (Mohammad, 2017). This treatment is also preserved the soft tissues (John et al., 2007; Qassadi et al., 2019).

In order to replace a single missing tooth, implant-supported single crowns have become a popular option (Assaf and Abu Gharbyeh, 2014). The two forms of prosthetic restorations that are affixed to dental implants are screw retained and cemented restorations (Kumari et al., 2021). The preferred procedure is typically determined by the clinician (Ahmed et al., 2018).

The current study's objectives included the development of a technique for interseptal instant dental implant placement, the identification of a precise location that is suitable for the implants, and the demonstration of step-by-step clinical procedures for interseptal immediate implantation with crown restoration.

2. MATERIAL AND METHODS

2.1. Approval Ethics

All the experimental procedures were performed according to the protocol approved by the ethical committee of the faculty of veterinary medicine, Benha University, Egypt, and provided approval number BUFVTM 01-06-023.

2.2. Animals

The present study was carried out for implantation of six endosseous implants in the mandibles of three dogs. These dogs were adult, (mean age 1.8±0.2 years), apparently healthy, male dogs, weighted 27±1 kg.

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The dogs were divided into 2 groups, three implants for each group:
Group A: The procedure was performed on three right mandibular rami of three dogs (using three implants).
Group B; the left mandibular sides of the same three dogs were used.

2.3. Dental implant

Two pieces titanium dental implants were used, the implant surface made completely alkaline with SLA (sand blasted, large grit, acid etched) protocol. The implants were of 14 mm in length and 3 mm in diameter.

2.4. *Alendronic acid* (Fosavance, Global Napi Pharmaceuticals 6th of October – Egypt) (Figure 1) was used for local application with the implants in group B.

Fig (1).A, Dental kit for Biodem implants. B, Biodem implants. C, Implant with the cover screw after opening. of D, E, Fosavance (bisphosphonate) F, MCS low speed contra CX 235.

Two implants were placed per each dog (one implant for each side of the mandible in each group). The placement of the implants was performed according to the guidelines provided by the manufacturer (Straumanns Dental Implant System).

2.5. Study design:

2.5.1. Preoperative right and left lateral Plain x-ray film: at 10 mAs and 25 Kv lateral views were performed in all dogs.

2.5.2. Computed Tomographic scans (CT scans):

The CT scans were planned with a tube setting of 130 kv and 160 mA by using a 64-detector row CT scanner (Toshiba). All dogs (three animals) underwent general anesthesia before the CT scanning. Computed tomography of the dog's heads, including the mandibles were performed. The height, width of the crowns and roots of the lower premolar tooth (1st, 2nd, and 3rd) were measured and recorded for all animals. The number, direction of each root was investigated to determine the suitable method of implant installation.

2.5.3. Animal grouping

After obtaining different measurements for each tooth, the immediate implant placement in the interseptal bone in the presence of healthy remaining roots was performed in two groups:
Group A: (The right mandibular sides) without local application of a bisphosphonate agent (alendronic acid)
Group B: (The left mandibular sides) with local application of a bisphosphonate agent (alendronic acid).

Each animal kept in a single box, fed only on soft food for 90 days. Each week, the animal secured without anesthesia and the site and the cover screw of the implant were brushed using toothpaste and rinsed.

2.6. Surgical procedures

2.6.1. The anesthetic protocol

Food and water were restricted for 12 hours before the surgery. All surgical procedures were performed under general injectable anesthesia. The anesthetic protocol was as follows: firstly, the dogs were premedicated with atropine sulphate (Misr Pharmaceutical Co. Egypt), administrated via intramuscular injection (30-100 mcg\kg body weight), half an hour before the anesthesia. Then, for the general anesthesia a mixture of ketamine (10mg\kg body weight) and xylazine (2mg\kg body weight) were injected intramuscular.

2.6.2. The procedures of implantation

In each dog, the mouth planned to be split into right and left halfes, and the mandibular second premolar crowns were planned to be extracted atraumatically(split mouth technique). This method, i.e., the crown extraction was a one-step procedure that preserved the available premolar roots and the surrounding bone. The sites of the implants were prepared using an implant surgical motor with internal and external irrigation pump. Then, to prepare the final reception sites for 3 mm screw type implants, each right site was drilled with a pilot drill 1 mm in diameter to a depth of 14 mm and finally by a drill of 2 mm in diameter (Figure 1F). During the drilling procedures profuse irrigation with saline was applied. After preparation of the socket sites, and before the fixture installation, each right socket site was injected with saline. After that, in their final placements, the left side implants were put in according to the identical procedures as the right socket sites. The left socket sites were also drilled, but the fixtures installations were done after application of grinded bisphosphonates tablet of dose 70 mg (Alendronic acid, Bp).
Finally, at the end of three months (90 days) abutments were inserted into both groups. Prophylactic Antibiotic injection was administered to the dogs during the first week after surgery with cefotaxime (50 mg/kg/b.i.d./ IM). The dogs' diet throughout the study period was soft dog feed. The dogs were registered in a control program sheet, and underwent regular cleaning (brushing) for both the teeth and the implants, three times a week using toothpaste with a brush. To achieve the optimum results, a three-month shealing period was scheduled.

2.7. Clinical examination

The animals examined weekly, for implant stability (percussion and pressure), mucous membrane changes, and tissues surrounding the implant, the implant tolerance and irritation.

2.8. Titanium crow restoration

2.8.1. Abutment placing

Standard abutments were used; these abutments were made of Titanium, and consisted of two pieces, i.e., the abutment and the abutment screw. The abutments were of 5mm heights, each one had a smooth collar extending from the implant head to the crown margin. The abutments were fixed, and retained by the implant head using a gold screw (Retention pin).

2.8.2. Abutment Level Impressions

The location of the abutment is necessary for direct abutment level impressions, followed by preparation and impression procedures akin to those used for traditional crown preparations.

2.8.3. Taking dental Impression

Alginate impression material (alginate powder) was shifted into a rubber bowl contained measured amount of water. The water and powder were combined together with an energetic motion. Then the alginate past was loaded onto a stock impression tray. The loaded tray was accurately, rigidly fitted on the abutment side involving the neighboring anterior and posterior tooth, until the alginate hardened impression was recorded, and gypsum casts were made to the tooth. The titanium crown fabrication was obtained from the dentistry laboratory in Zagazig governorate.

2.8.4. Implant crown cementation and Fixation

The crown restoration was completely loaded onto the intaglio surface of the crown with bis-acrylic restorative material (Acrylic Resin cement). Finally, the crown restoration was seated in lingual to buccal or buccal to lingual direction. After initial polymerization or gel state of resin, excess cement is removed, glycerin covering the gum was applied and all surfaces were allowed to polymerize and crown was secured until bis-acrylic is fully cured.

2.9. Statistical analysis

On the basis of the 3 Rs standers (Replacement, Reduction and Refinement), which improving the Planning and Reproducibility of Animal Experiments (Smith and Lilley 2019), a limited number of animals was used, because of the very high costs. The statistical procedures in this study were performed with a commercially available software program (SPSS, Version 16.0; SPSS Inc., IL, USA). Data were evaluated for normality using the Shapiro-Wilk test, and the data were determined to be normally distributed and are presented as mean ± standard deviation.

3. RESULTS

3.1. Group A (n=3)

Once the animal underwent complete anesthesia the mouth was kept open via insertion of the tubular part of the 10ml syringe in both lower and upper fourth premolar teeth. The 2nd premolar tooth's crown was bluntly removed by the tooth extractor from the free gingiva that makes up the gingival edge, which was visible during inspection and covering the tooth crown (Figure 2). The crown in the right side was extracted at the cemento-enamel junction (CEJ) (the junction between the anatomical crown and root), then extracted with the right-side tooth extractor, leaving the marginal gingiva completely, while for the left side crowns, the left tooth extractor was used (Figure 2).

The pre-operative X ray images and CT scans revealed slight curving from the upper lateral part to the lower end medially of the both roots of the 2nd premolars in all dogs (Figure 3, 4).

A1 mm diameter pilot and 14 mm depth were used to drill a reception site in the interseptal part between two roots of the 2nd premolar. A pilot of 2 mm diameter was used to drill the final reception sites, as the diameter of the implant is 3 mm. profuse irrigation with normal saline was performed during the drilling procedures for cooling and rinsing. The implants were then installed and seat into its final positions by using of adjustable mechanical torque wrench. After accurate complete placement of the implant the cover screw was retained into the implant by either mechanical or manual screw-driver (Figure 2).

The procedures were anatomically feasible, no blood vessels or nerves in the course of the pilot and subsequently the implant.

The site of the implant was easily accessible, the location in the free part of the lower jaw easily reached using both right and left hands of the performer. The crown of the lower second premolar tooth was clearly visible without visual aid.

For the 90 days of the post-operative examinations, the animals were examined at baseline, 30, 60 and 90 days. These periodical examinations showed that the mucous membrane of the gingiva was apparently healthy with no signs of inflammation or swelling. The animals tolerate the presence of the implants in their mouth. There were no any signs of discomfort or irritation (Figure 5). CT Periodical examination of animals group for stability of the implant in the reception site were revealed no deviation or loosening and remained retained in their sites (Figure 5).

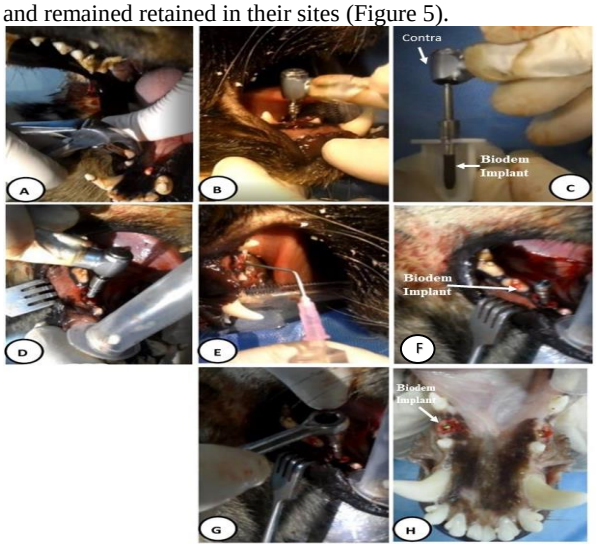

Fig (2). Steps of implant placement: A: extraction of the crown of the 2nd premolar. B: drilling interseptal reception site for the implant. C: Loading of the contra with sterile Biodem implant. D: Mechanical insertion of theBiodem implant. E: irrigation and flushing of the reception site. Sometime use Fand G, Manual insertion of Biodem implant using adjustable mechanical torque wrench. H: installation of the cover screw in the implant

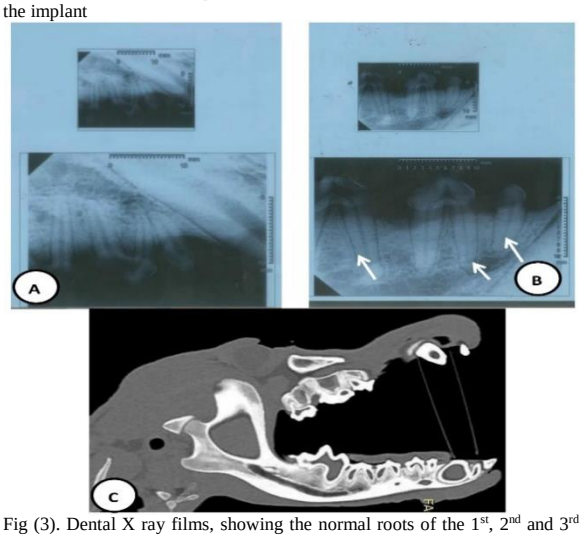

Fig (3). Dental X ray films, showing the normal roots of the 1st, 2nd and 3rd lower premolar (A and B). Reformatted, sagittal plane computed tomography image of the lower Jews of dogs showing the normal roots of the 1st, 2nd and 3rd and their relations (C).

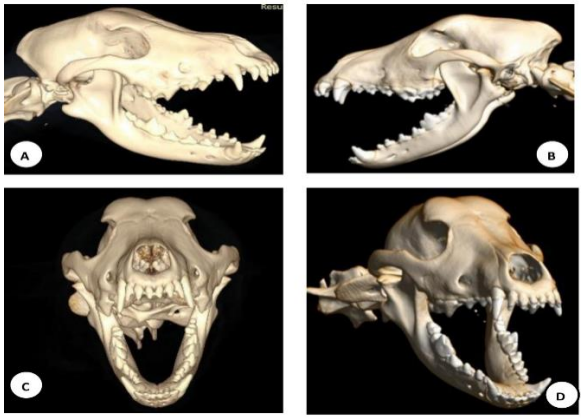

Fig (4). 3D reformatted computed tomography images of the lower Jews of dogs showing the normal premolar and molar teeth

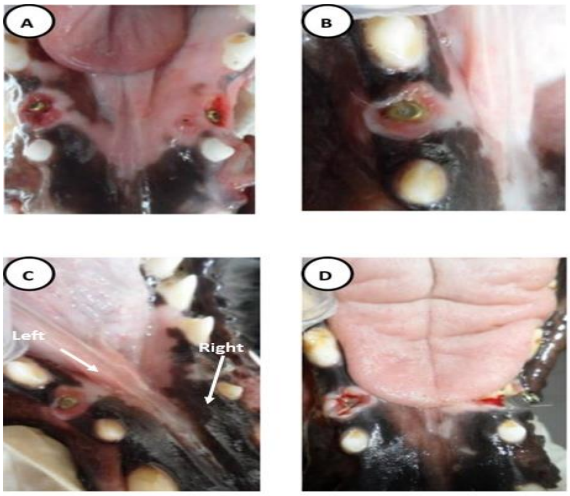

Fig (5). Showing changes in the gingival mucous membrane and the stability of the implants in Group (A), right side and group (B) left side). A:15 days after implantation; the implant in both sides are apparently stable with slightly inflamed mucous membrane of the gingiva in group (B), B: apparently healthy gingival mucous membrane in group (A), C:30 days after implantation; stable implant in group (A) (right side),while loosening and evulsion of implanting group (B) (Left side), D:60 days after implantation , stable implant in group (A)) (right side), loosening and evulsion of implant in group (B)(Left side).

Group B (n=3)

All animals of this group were performed as those in the group (A) except that before the implants installed directly in its reception seats, the socket was filled with dose 70mg bisphosphonate, then the procedures were completed as group A.

The procedures were anatomically feasible, no blood vessels or nerves in the course of the pilot and subsequently the implant. Also, the site of the implant was easily accessible, the location in the free part of the lower jaw easily reached using both right and left hands of the performer. The crown of the lower second premolar tooth was clearly visible without visual aid

For the 90 days of the post-operative examinations the animals were examined at baseline, 30, 60 and 90 days. These periodical examinations showed that the mucous membrane of the gingiva was slightly swollen with signs of inflammation. The inflamed gingiva covered the cover screw of the implant in one animal 15 days post-operative (Figure 5).

The animals tolerate the presence of the implants in their mouth for the first two weeks postoperative. There were signs of discomfort or irritation started at the first week postoperative.

Clinical examination by percussion and pressure revealed the implant movable in one animal at 21 days. The movability of implant clearly appeared at 45 days in the other two animals.

CT Periodical examination of animals group (30, 60 and 90 days) for stability of the implant in the reception site revealed deviation and loosening in all animals. The implant loosed and disappeared from their site in 30 days in one animal, and at 60 days in the other two animals.

In all three dogs the left implant loosed and disappeared. With apparent small localized swelling of this site. After 90 days the implants of the right side were still stable in place. Titanium crowns were restored by the accurately restrained abutment, after taking crown impression (Figure 6, 7, 8).

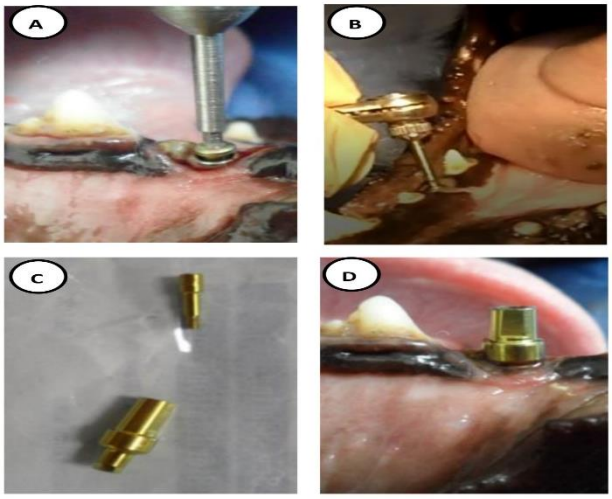

Fig (6). Showing abutment placement and fixation. Aand B: loosening and removal of the cover screw by using Mechanical screw-driver, C: the abutment and its securing golden screw, D: abutment loading into the implant and securing by the golden screw.

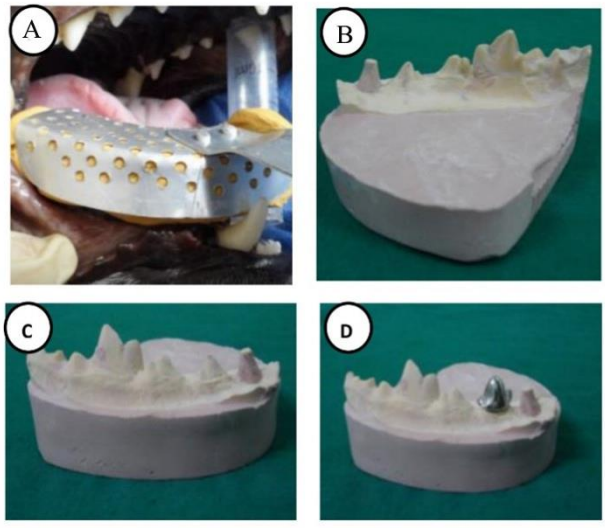

Fig (7). Impression taken with addition alginate. A: the impression material sets in the aluminum tray and impression taken after removal of the cover screw by using Mechanical screw-driver. B and C: gypsum cast for the titanium crown. D: Titanium crown set onto the gypsum cast

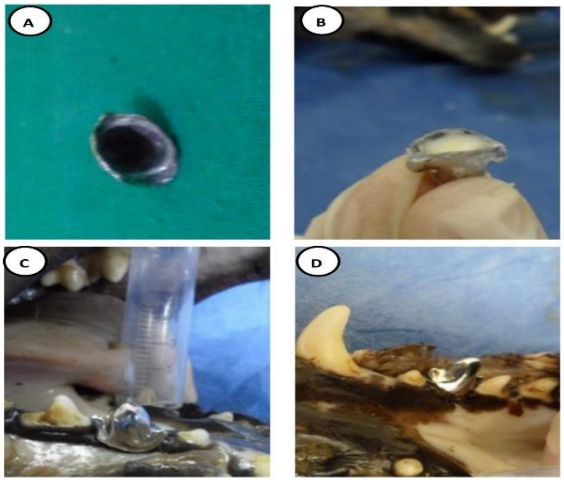

Fig (8). The crown restoration and fixation of the titanium to the abutment. Aand B: Crown completely loaded onto to the intaglio surface with bis-acrylic acrylic Resin cement. Cand D: The crown restoration seated in lingual to buccal or buccal to lingual direction. Crown was secured until bis-acrylic is fully cured.

4- DISCUSSION

This study was described in details the development of a technique for interseptal immediate dental implant placement in dogs. The safety, the feasibility, the survival of immediately placed implants was all examined periodically for three months after the procedures. The technique used in this study differ from the commonly used implants technique in that, it did not include the removal of premolar roots. This step, which was the preservation of premolars roots, was helpful, and ease the implantation process, as well as enhance the stability of the implant (Rong et al., 2009; Vera et al., 2012; Brownfield et al., 2012). Numerous experimental and clinical researches (Cohencaand Stabholz., 2007; Sapir and Shapira., 2008) supported the strategy of leaving roots to prevent alveolar bone remolding.

In group (A) of this study, all the implants were fixed and stable, while those of group (B), in which the Bp used with the implants were all failed. These results of interseptal immediate implantation in group (A) are in agreement with results of (Gray and Vernino, 2004), who reported that the implants positioned in contact with monkey model roots have been effectively loaded for three months. The positive results of the study done by Davarpanah et al., (2009) were also agreed these results that include implant placement in close proximity to ankylosed root fragments should not hinder implant integration or negatively impact occlusal function. The results of group (B) may be attributed to the usage of bisphosphonate or Alendronic acid, as this substance may be not suitable for the stability of implants in dogs.

The preservation of roots in the technique used in this study was also improved implant osseointegration from changed implant surface topography, roughened surface which result in early bone-to-implant contact (Rong et al., 2009), and provided greater preservation of alveolar bone from resorption and thus greater implant stability (Vera et al., 2012; Brownfield et al., 2012). The implants placed in contact with roots (non bony tissue) achieve classical osseointegration on the part of the implant surface that comes in contact with bone; on the other hand, a mineral integration is gained at the places in contact with the non-bony mineralized tissues (Szmukler-Moncler et al., 2014).

The commonly used implantation approach that include removal of roots required invasive surgery with several surgical procedures to complete the implant treatment and decreased the patient acceptance so alternative approach is needed to meet the patient requirements for a non-invasive and more effective implant treatment (Grayand Vernino, 2004; Davarpanah et al,, 2009).

The result of the present study come in agreement with that reported by Szmukler-Moncler et al. (2014) who showed that in six patients, seven implants (4 in the mandible and 3 in the maxilla) were inserted through a remnant root. The root-implant interface did not exhibit any abnormal features, and the implants were clinically stable. Barakat et al. (2017) was also reported that the remaining root with immediate implant placement (socket shield technique) is an effective method for achieving osseointegration without any inflammatory reaction, as it preserves alveolar bone and this return to the periodontal ligaments vascular supply.

5. CONCLUSION

In conclusion, the use of interseptal immediate dental implantation, without root extraction was suitable, feasible and accessible in dogs.

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