Factors influencing abutment selection in esthetic dental implants: A case report

Tirada Yingprasert[1], Pravej Serichetaphongse[2], Atiphan Pimkhaokham[3]

[1] Master Degree Student in Esthetic Restorative and Implant Dentistry, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand.

[2] Department of Prosthodontics, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand.

[3] Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand.

Abstract

The aim of case report was to investigate the suitable color of abutment by measuring the optical effects of six different neck colors of temporary abutment that transmitted through the peri-implant mucosa at the upper right central incisor implant. The six commercial temporary abutments were covered by resin composite shade A1, A2, A3, A3.5, A 4 and pink. The color different were measured by the colorimeter, ShadeEye NCC,after the peri-coronal tissue is fully developed.The color of peri-implant mucosa of the implant site and natural tooth were compared for color difference index (ΔE). The result showed that the optimized implant neck color in this case report was shade A3. Thus, the final restoration is computer-aided design and computer-aided manufacturing (CAD/CAM) zirconia abutment, ATLANTIS, shade A3 and the lithium disilicate glass ceramic crown (IPSe.max Press)

Keywords: anterior implant restoration,ATLANTIS, gingival color, implant in the esthetic zone, peri-implant mucosa, single-tooth implants

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Corresponding author:
Pravej Serichetaphongse
Esthetic Restorative and Implant Dentistry Program, Faculty of Dentistry,
Chulalongkorn University,
34 Henri-Dunant Rd., Wangmai,
Patumwan, Bangkok, 10330 Thailand.
Tel: 0-2218-8662
Email: pravejs@hotmail.com

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Introduction

In modern society, the esthetic aspects of implant reconstructions play an important role in dental treatment success. The dental implants are an alternative treatment for conventional tooth-supported reconstruction.[1] The single-tooth implant demonstrated thehigh success rate and patient satisfaction.[2, 3]

The predominanttitanium abutmentis the gold standard due to their excellent material stability and biologic integration.[4] However, the grayish color of soft tissue around the titanium abutments may impair the esthetic outcome in anterior region.[5-8] Jung *et al.*[5] investigated the shine-through effect of titanium and zirconia with and without veneering ceramics of three different mucosalthickness (1.5, 2 and 3 mm) by using the spectrophotometer. Titanium induced the most prominent color change, while zirconia did not induce visible color changes in 2.0-mm-thick and 3.0-mm-thick mucosa, regardless of whether it was veneered. However, with a mucosa thickness of 3.0 mm, no change in color could be distinguished by human eye on any specimen. Park *et al.*[6] investigated the difference in optical appearance of peri-implant mucosa and analyzed the effects of titanium implant neck colors transmitted through the marginalmucosa. They found that the color of soft tissue around the titanium implant was significantly different compared with the gingival of natural teeth.

To overcome this problem, zirconia abutments were recently introduced in implant dentistry and have demonstrated good long-term stability for the single tooth implants.[9, 10] The predictability of an esthetic implant outcome can be improved by masking the grayish color of the implant neck. Ishikawa-Nagai *et al.*[7] investigated an optical solution to eliminate the undesirable shine-through effect of implants on peri-implant mucosa by using the different eight colors of paper strip. The light pink is the most effective to mask the color of the underlying titanium abutment.Bressan*et al.*[11]analyzed the influence of the gold, titanium and zirconiaabutment materials on the color of the peri-implant soft tissue. The result was the peri-implant soft tissue color appears to be different from the soft tissue color around natural teeth, no matter which type of restorative material was selected.

The purpose of this case report was to investigatethe optical effects of six different neck colors of temporary abutment that transmitted through the peri-implant mucosa, and to select an optimized implant neck color for this patient.

Clinical case report

A 38-year-old female presented with anedentulous area at the tooth 11 (upperright central incisor). Her chief complaint was she does not feel confident in her smile. The tooth 11 was extracted for 20 years as a result of the failure of post and core with crown.The evaluation of the patient's condition confirmed that restoration of the tooth 11 area could be best accomplished with a single implant restoration. No sign of tooth mobility or periodontal disease was detected. An Angle's classification I was present on both left and right sides with normal horizontal overlap. The vertical overlap is 3 mmand high lip line. The midline of maxillary teeth was shift to the right 2.5 mm. The anterior mandibular teeth werecrowded. (Figure 1, 2)

The patient refused orthodontic treatment. She was satisfied with the existing alignment of her teeth. Radiographic evaluation (cone beam computed tomography, CBCT and periapical view) of the area of tooth 11 was classified as Seibert's classification I, with a bucco-lingual width of 2.46 mm, mesio-distal width of 3.02 mm,and apico-coronal length of 11.10 mm (Figure 3A, 3B). Odontoma at the area of tooth 11 was observed.An implant esthetic risk profile was reviewed and a medium esthetic risk was

determined. (Table 1)

Surgical Phase: The procedures were done under local anesthesia (4% Articaine Hydrochloride with 1/100,000 epinephrine, Septodont, Saint-Maur-des-FossésCedex, France). An odontoma was removed before the bone block was harvested from the right retromolar region. Four months after surgery, the patient was re-evaluated for the implant installation and the CBCT was obtained (Figure 3C). The osteotomy site was prepared for 4.5 x 9 mm bone levelimplant (Astra Tech, Mölndal, Sweden). The implant was carefully installed into the prepared osteotomy site.A grafting material (Bio-Oss,GeistlichPharma, Wolhusen, Switzerland) was carefully placed into the

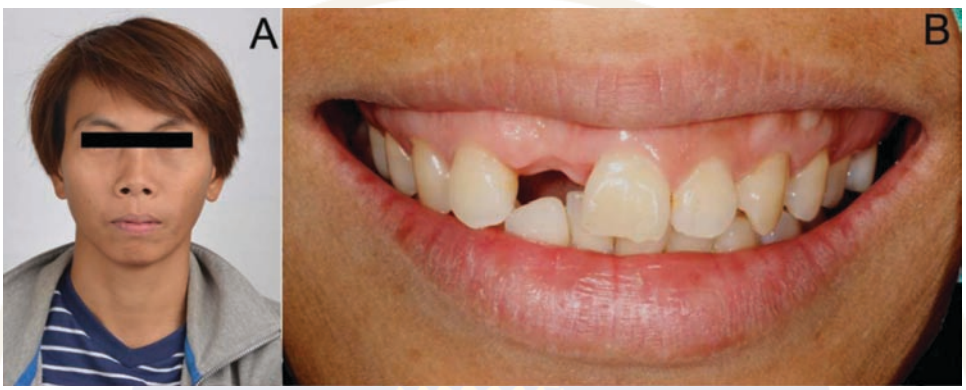

Figure 1 An extra-oral view of 38-year-old female patient (A), she was great vertical overlap 3 mmand high lip line (B).

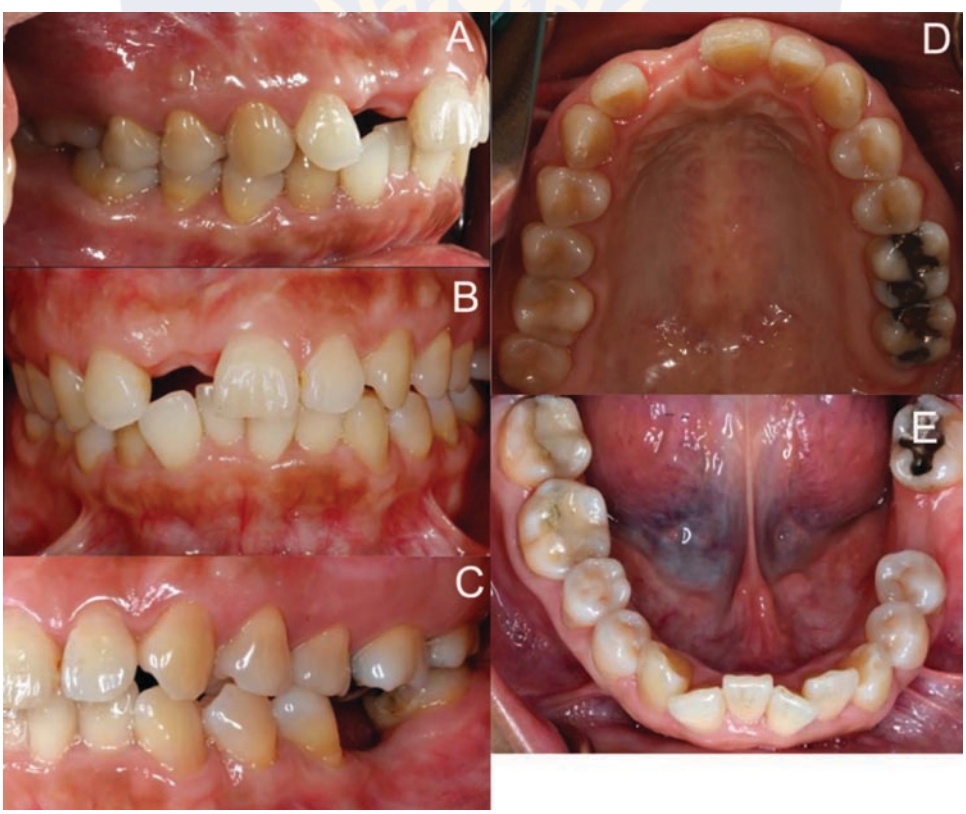

Figure 2 Pre-operative intraoral photos in right, frontal, left, occlusal of maxillary teeth and occlusal of mandibular teeth view (A, B, C, D, E).

defect and was covered with a resorbable collagen membrane (Bio-Gide,GeistlichPharma, Wolhusen, Switzerland). The denture was adjusted to prevent any pressure on the buccal flap. (Figure 4)

Prosthetic Phase: Enameloplasty was performed on upperleft central incisor 1 mm. The screw-retained provisional restoration

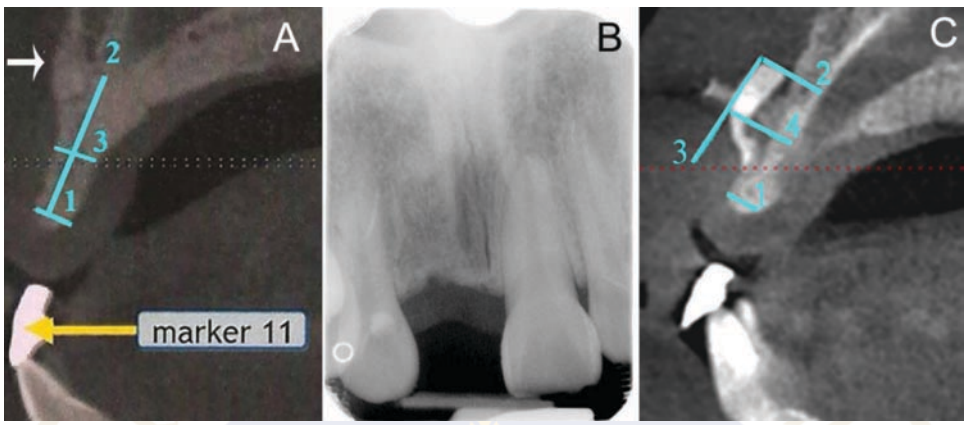

Figure 3 CBCT (A) and radiographic peri-apical view (B) at the implant site (tooth 11) show definite implant position with Seibert's classification I (1 = 2.46 mm, 2 = 11.10 mm, 3 = 3.02 mm) and odontoma is presented (white arrow), CBCT after 4 months (C) of bone augmentation showed bucco-lingual width of 5.15 mm (1 = 2.7 mm, 2 = 5.27 mm, 3 = 10.55 mm, 4 = 5.15 mm).

Table 1 An implant esthetic risk profile was reviewed with the patient and medium esthetic risk was determined

Esthetic Risk Factors	Low	Medium	High
Medical status	Healthy patient and intact immune system		
Smoking habit	Non-smoker		
Patient's esthetic expectation			High
Lip line			High
Gingival biotype		Medium-scalloped, Medium-thick	
Shape of tooth crowns	Rectangular		
Infection at implant site	None		
Bone level at adjacent teeth		5.5 to 6.5 mm to contact point	
Restorative status of neighboring teeth	Virgin		
Width of edentulous span	1 tooth (≥7 mm)		
Soft-tissue anatomy	Intact soft tissue		
Anatomy of alveolar bone		Horizontal bone deficiency	

(TempDesign, Astra Tech, Mölndal, Sweden) was used to sculpt the peri-coronal tissue to duplicate the contralateral central incisor.The tissue contour was evaluated and provisional restoration was modified to allow soft tissue maturation. Five months after implant placement, the desired emergence profile had been established (Figure 5). The final impression was made and the thickness of peri-implant mucosa was measured.

In order to evaluate the proper type of abutment color,thetested abutments were prepared. Five temporary abutments (4.5/5.0, Astra Tech, Mölndal, Sweden) were covered by five body shadesresin composite (Premise, Kerr, California, USA) (A1, A2, A3, A3.5and A4). One temporary abutmentwas covered by pink shade resin composite (CERAMAGE, Shofu Dental GmbH, Ratingen, Germany).Twoprefabricated abutments, TiDesign and ZirDesign, (4.5/5.0,

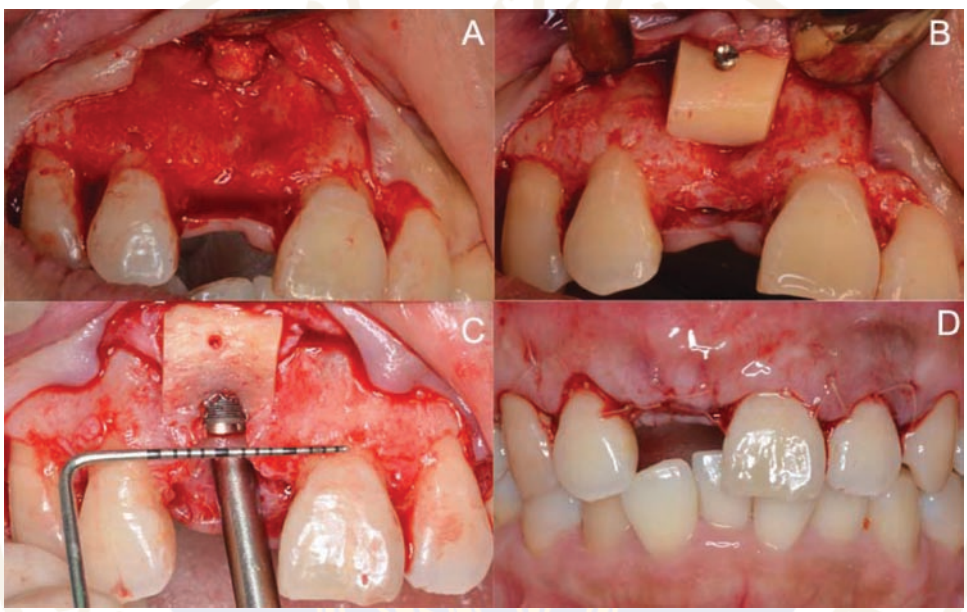

Figure 4 Surgical phase: the odontoma was removed (A), bone block was secured in placed with a screw (B), the implant (4.5 x 9 mm, bone level implant, Osseospeed, Astra tech, Mölndal, Sweden) was properly positioned into the prepared osteotomy site and dehiscence at the facial area of the implant occurred (C). Guided bone regeneration procedure was performed to correct the defect. A 4mm healing abutment was placed and the area was sutured (D).

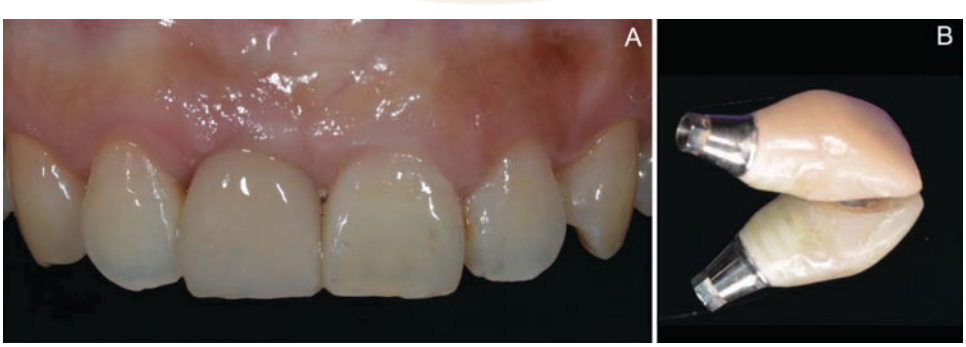

Figure 5 Five months after implant placement (A), a screw-retained provisional abutment was fabricated (TempDesign, Astra Tech, Mölndal, Sweden) (B).

Astra Tech, Mölndal, Sweden) also used as a baseline in this study.

All six tested temporary abutments were prepared by indirect technique. Briefly, a silicon putty impression material was mixed and placed in a dappen dish. While the putty material was still soft, the provisional restoration was placed directly in the soft mix. The gingival third of the crown was immersed in the putty material. After complete setting of the putty material, the provisional restoration was removed, and tested abutment was screwed to the implant replica (Astra Tech, Mölndal, Sweden). A resin composite was added to fill the area of the gingival contour.[12] (Figure 6, 7)

Color measurements were taken after the final impression appointment. The measurements were obtained using a colorimeter (ShadeEye

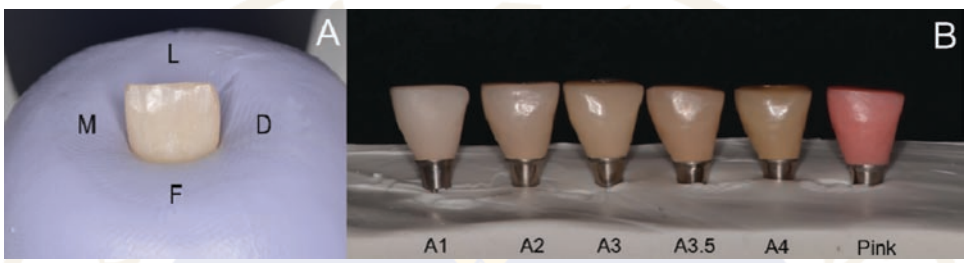

Figure 6 Preparation of six tested abutments. The gingival third of the provisional crown was immersed in the putty material (A), six shade tested abutments A1, A2, A3, A3.5, A4 and pink were prepared (B).

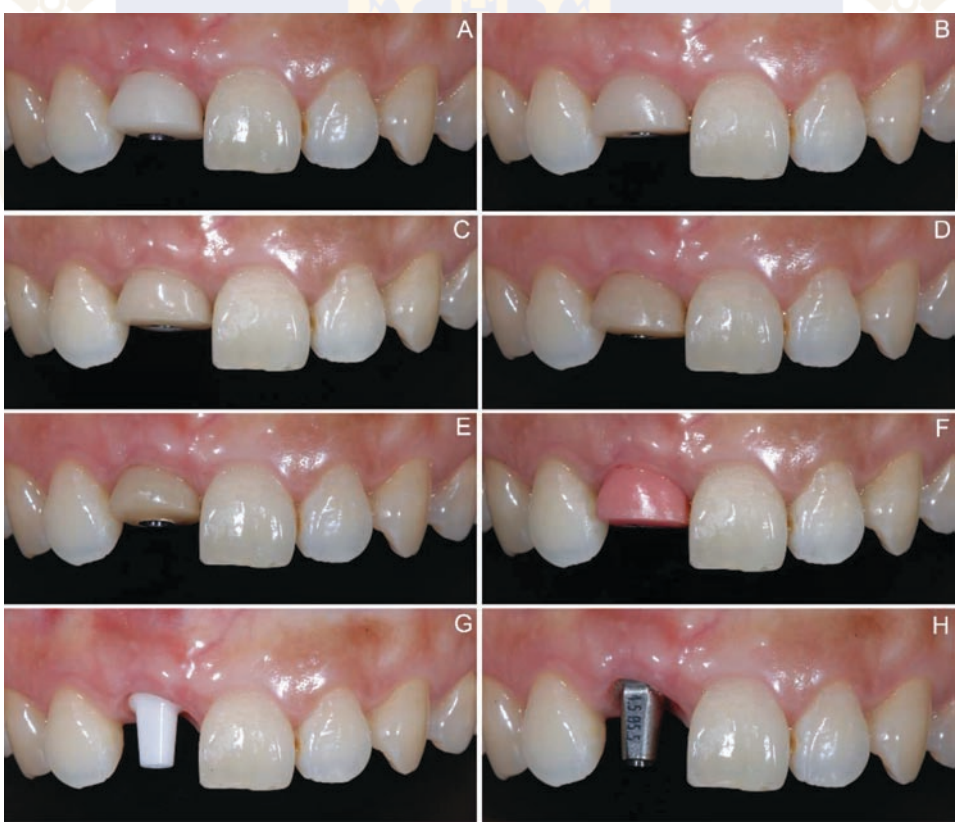

Figure 7 All tested abutment shade A1 (A), A2 (B), A3 (C), A3.5 (D), A4 (E), pink (F), zirconia abutment (G) and titanium abutment (H) were placed at the area of implant 11.

NCC, Kyoto, Japan). The device was calibrated at the start of each measurement with a white calibration tile provided by the manufacturer. It is a mobile, wireless measuring unit that analyzes the tooth shade digitally, and instantaneously transmits the information to the main unit through an infrared interface.[13] The measurement was performed by single operator capturing an area of 2 mm around the gingival margin of the selected area (mid-buccal of the peri-implant mucosa of tooth 11). The plastic stent was used in order to confirm the same tested position after the testedabutment wasinserted into the peri-implant mucosa for 20 minutes to allow the soft tissue to settle. The three measurement values of each abutments were averaged. The color of the gingiva of upper right lateral incisor (tooth 12) was measured as a control. (Figure 8)

The overall color difference between the tested abutments and the control site was calculated using thisequation: $\Delta E = [(L^*_t - L^*_c)^2 + (a^*_t - a^*_c)^2 + (b^*_t - b^*_c)^2]^{1/2}$ by the Microsoft Excel program 2013 (Microsoft, Washington, USA). The most effective tested abutment indicating the smallest ΔE was determined. According to the CIELAB units, close color mismatch was in the range of 2 to 4ΔE units. ΔE less than 1 was considered to beexcellent and that of over 3.6 was considered to be a clinically distinguishable color difference.[14, 15]

Results

The mean ΔE values of the eight tested abutments are shown in Table 2. A comparison of colors of the peri-implant mucosa (tested site) with tested abutment and natural gingiva (control site) demonstrated that all tested abutment except for shade A1, A2 and A3 showed the clinically distinguishable color changeswhich color difference value higher than 3.6. It was not considered to be clinically acceptable. The tested abutment shade A1, A2 and A3 have less apparent effect on the

Figure 8 Plastic stent was used to confirm the tested position (A,B), ShadeEye NCC (Shofu Inc, Kyoto, Japan) (C).

Table 2 The mean ΔE values of the eight tested abutments

Tested abutment	ΔE*
A1	3.3
A2	3.1
A3	2.8
A3.5	6.6
A4	6.6
Pink	3.7
Zirconia	5.0
Titanium	7.2

*ΔE = Color difference index

peri-implant mucosa with a mean ΔE value of 3.3, 3.1 and 2.8, respectively. Thus the tested abutment shade A3 exhibited the lowest mean ΔE value of 2.8. However, the titanium abutment caused the most prominent color differences with ΔE value of 7.2.

To optimize the esthetic results, the customized zirconia abutments (ATLANTIS, Dentsply, USA) shade A3 was chosen withlithium disilicate glass ceramiccrown (IPS e.max Press, IvoclarVivadent, Schaan, Liechtenstein).The abutment was torqued at 25 Ncm according to the manufacturer-recommendation and the screw access was sealed with plumber tape and resin composite. The crown was cemented using temporary cement (Temp-Bond, Kerr, California, USA). The soft tissue was sculpted to mimic the upper left central incisor. (Figure 9)

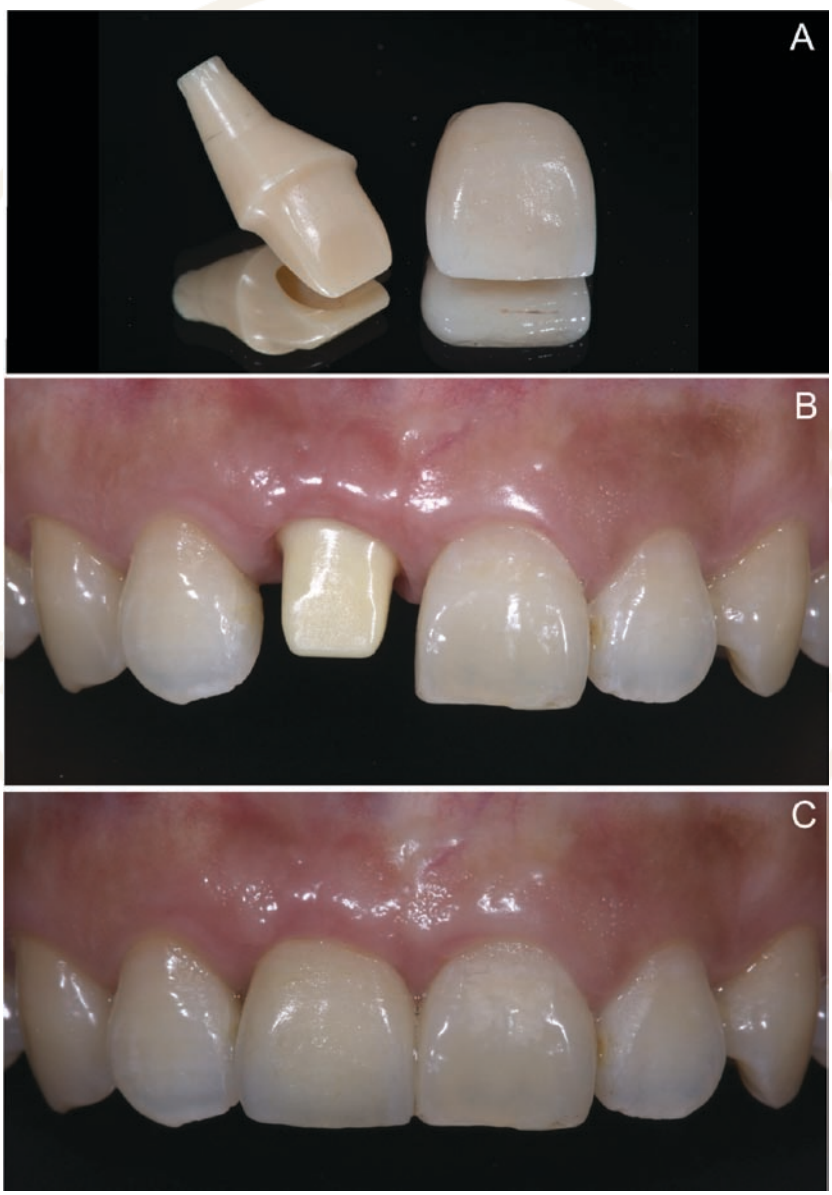

Figure 9 Final restoration: the customized zirconia abutment (ATLANTIS, Dentsply, USA) and lithium disilicate glass ceramiccrown (IPS e.max Press, Ivoclar Vivadent, Schaan, Liechtenstein) (A), the abutment was torquedat 25 Ncm according to the manufacturer-recommendation (B) and the e.max crown was delivered to the right position (C).

At 4-month recall, the peri-implant mucosa of tooth 11 was measured with ShadeEye NCC. The color difference value was 3.4 which less than 3.6. It was considered to be clinically acceptable. The patient was satisfied with the harmony of restoration, soft tissue color and soft tissue contour. She also reported satisfaction with both function and esthetics, no gingival recession, bleeding, exudate orimplant mobility were found.The peri-apical radiograph shown no marginal bone loss. Oral prophylaxis was given. (Figure 10)

Discussion

The appropriate treatment planning and the suitable surgical and prosthetic techniques must be carefully considered in esthetic zone. Three-dimensional bone volume available, the periodontal biotype, the length of biologic width in relation to the crestal bone of the tooth that will be lost, the tooth shape, the position of the interproximal contacts, the position of the bone crest, the position and alignment of the implant relative to the proposed implant crown are the important factors to achieve the esthetic results of anterior dental implant.[16]

The autogenous bone was used because of outstanding characteristics, including excellent biocompatibility, osteogenic potential, osteoinduction and osteoconduction.The alveolar bone grafting with autogenous mandibular bone is well tolerated by the patients, produces minimal side effects and is associated with high implant success and survival rate.[17]

The gingival biotype is an important factor to achieve a predictable esthetic outcome. Thin gingival biotype issusceptible to gingival recession following surgical and restorative procedure and tends to be delicate and almost translucent in appearance, contributing to an undesirable shine-through effect of the underlying material. The esthetic appearance of peri-implant mucosa is importance in implant dentistry, particularly in patients with a high lip line.In this

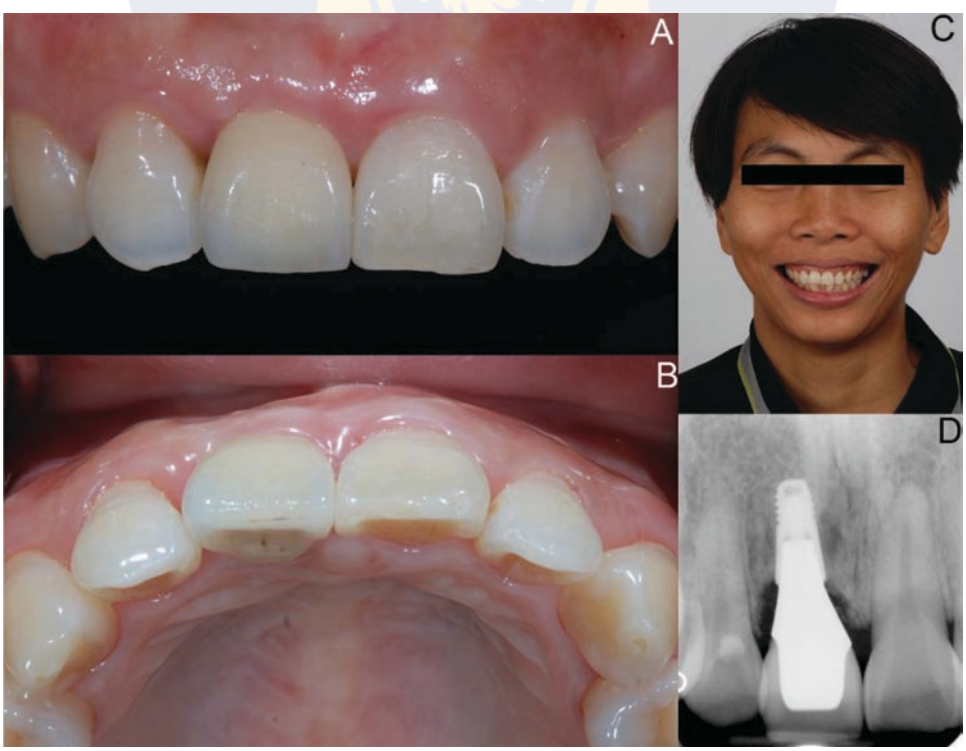

Figure 10 4-month recall, the patient reported satisfaction with both function and esthetics (A, B), the frontal views of patient (C) and the peri-apical radiograph showed no marginal bone loss (D).

particular case, the thickness of peri-implant mucosa at the area of 1 mm, 2 mm and 3 mm from the gingival margin are 1.2 mm, 1.7 mm and 2.2 mm.The use of titanium abutmentimpair the esthetic outcomeof dental implant with a grayish appearance of peri-implant mucosa even in peri-implant mucosa thickness of 1.5 and 2.0 mm.[5, 6, 8]

Zirconia abutment was preferred to overcome the unnatural gingival problem. In addition, fracture strength of prefabricated zirconia abutment was high enough to withstand maximum human occlusal load.[18, 19] ATLANTIS abutments have several choices of anatomical emergence profiles which are designed by using the ATLANTIS VAD software (Dentsply, USA). The anatomical shape of abutment may help to support the surrounding soft tissues and influence the stability of peri-implant mucosa.[20] In anterior region, the use of CAD/CAM abutments is related to a better soft tissue stability.[21] Margin are designed at an ideal level for easy and safe removal of excess cement. Many colors of zirconia abutment can be chosen for the esthetic result.

Over the last decade, computerized shade-matching systems have appeared on the market. This innovative technology offers better accuracy, improved efficiency, and esthetically benefits to patients, dentists, and technicians. These systems analyze the color of the natural teeth and calculate the exact ratio of hue, chroma and value. This improved flow of information encourages the fabrication of predictably accurate andhighly esthetic restorations, while the frequency of remakes is reduced.

In this case, CAD/CAM customized zirconia abutment (ATLANTIS) shade A3 was used due to the result of this study that the tested abutment shade A3 showed the lowestΔE value (2.8). Four months after the crown was cemented, the ΔE value of peri-implant mucosa compare to the natural gingiva was 3.4. The use of resin composite as tested abutment to evaluate the color of peri-implant mucosais a new technique which never been reported. It better than using the paper strip[7] or painting healing abutment with nontoxic acrylic paint[22]. Moreover, the resin composite is commonly use in general dental procedures.However, resin composite and zirconia are different materials that the color of peri-implant mucosa might be slightly affected.Four months after the zirconia abutment was torqued and IPS e.max Presscrown was cemented, the ΔE value was 3.4 which higher than the tested abutment (A3) but still less than the clinically distinguishable color difference (ΔE = 3.6). The peri-implant mucosa around titanium and zirconia showed color differences when compared to the natural gingiva but the peri-implant soft tissue around zirconia demonstrated a better color match to the soft tissue at natural teeth.[23]

There was a study reported that pink color abutment is possible to improve gingival esthetics,[7]however our case report showed the pink abutment was not improve the color of peri-implant mucosa. Similarly, the study of Dominik *et al.*[24] demonstrated pink-veneered zirconia abutments failed to positively influence the esthetic outcome. Heppe *et al.*[25] presented the use of fluorescent light orange-veneered zirconia abutment, the result showed that, the peri-implant mucosa was not difference to the natural teeth. From our case report, it might be concluded that the reddish-yellow color (A3) can enhance the peri-implant mucosain this patient.

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Ethical Approval: None (Case Report)

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