

Role of Gingival Phenotype in Treatment Planning Maxillary Anterior Implants

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Abstract

During treatment planning maxillary anterior dental implants, having adequate bone and soft tissue support is essential for esthetic and functional success. In evaluating tissue support around potential dental implant sites, one of the most important assessments is the gingival phenotype around the potential implant site. Gingival biotype refers to the thickness of gingival tissue in the facial to palatal dimension. In assessing gingival biotype for sites requiring dental implants, it can be classified as thick if more than 2 mm of facio-lingual gingival exists and thin if there is less than 2 mm of tissue thickness. There is a direct correlation between thinness of gingival biotype and gingival recession following surgical and restorative procedures. This tissue response varies following dental surgery, trauma or bacterial infection. While thicker phenotypes are linked to health, areas with thin gingival tissue are linked to recession and loss of buccal plate. As a result, when assessing gingival phenotype, the goal is to identify the tissue type and ensure that thin phenotypes can be converted to thicker phenotypes prior to implant placement and restoration. The goal of this article is to review gingival phenotype around dental implants, modifications that are needed in dental implant therapy when thin phenotypes are noted and how gingival phenotype relates to overall dental implant success.

Keywords: *Gingival Phenotype; Planning Maxillary Anterior Implants*

Introduction

In treatment planning dental implants in the anterior area of the mouth, a number of factors affect overall functional and esthetic success of dental implants. These include precise positioning of dental implants, adequate tissue volume to allow adequate tissue contours and preservation of the interproximal papilla and restorations that are in harmony with adjacent teeth. Tissue biotype is a significant factor that affects the volume of tissue present around a potential implant site. Thick gingival phenotypes have 2 mm or more of gingival thickness and are associated with dense fibrotic tissue with wide band of attached gingiva [1]. Usually, sites with thick gingival biotypes have thicker flatter osseous form that is associated with dense fibrotic tissue, the tissue has increased resistance to infection, and is less prone to recession or bone loss [1]. Tissue around sites with thin biotypes are usually more delicate, with minimum amounts of attached tissue [1]. Underlying bone usually is very thin and minimal in quantity with a high chance of dehiscence and fenestration defects [1]. Areas of the mouth with thin gingival biotypes are at risk of soft tissue compromise following surgical healing involving gingival recession as well as loss of underlying buccal plate.¹ In treatment planning maxillary anterior dental implants, it is therefore essential that the biotype is identified and modifications in treatment implemented to change the biotype prior to dental implant therapy due to the differences that occur in healing response (Figures 1-5).

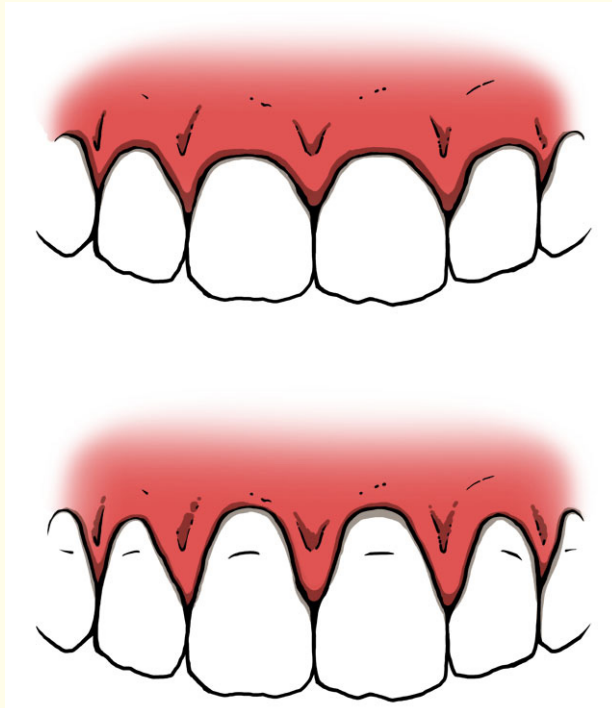


Figure 1: Diagram showing thick versus thin gingival phenotypes.



Figure 2: Patient with thin gingival phenotype.



Figure 3: Connective tissue graft to improve phenotype prior to extraction of anterior tooth.



Figure 4: Connective tissue graft in place.

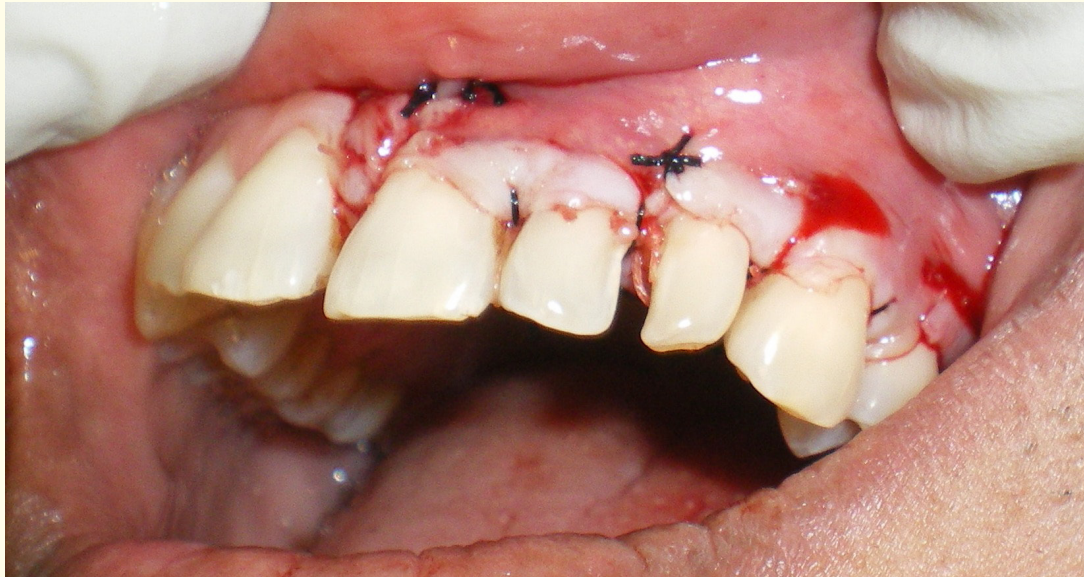


Figure 5: Connective tissue graft flap sutured.

Thickness of gingival tissue affects the amount of blood supply to bone and also gingival tissue, with thicker tissue having more blood supply and being less prone to bone loss and recession [1]. Tooth extractions with patients that have thin gingival biotypes result in more dramatic bone resorption with significant loss of bone in the lingual and apical direction during bone remodeling. Atraumatic tooth extractions with tissue preservation techniques are essential to preventing significant tissue loss and esthetic compromise [1].

Characteristics of gingival biotypes

In evaluating gingival biotypes, the use of the term “gingival phenotype” was advocated by the 2017 World Workshop consensus on Periodontal and Peri-implant diseases as a replacement for the term “biotype” the term “gingival phenotype” takes into consideration gingival volume, and variations in width of keratinized tissue as well as the thickness of the bone in the buccal plate [2]. In assessing thickness of gingival tissue, tissue phenotype can be classified as thick and flat versus thin and scalloped [3]. Characteristics of sites with thick gingival phenotypes include flat soft tissue and bone architecture, containing dense fibrotic tissue, it usually is associated with large amounts of attached gingiva, and thick osseous form, it is usually resistant to acute trauma and can react to periodontal disease with formation of pockets and infra-bony defect formation [4].

Characteristics of sites with thin gingival phenotype include that gingival tissue associated with it has scalloped soft tissue and bone architecture, delicate friable tissue, minimum attached gingiva present and thin bone that is characterized by dehiscence, fenestration as well as tendency to tissue perforation [4]. In evaluation of the overall tissue response, Kao., *et al.* contrasted the types of responses to inflammation, surgery and tooth extraction, and noted that while in response to inflammation, sites with thick biotypes had a tendency for fibrotic changes, and pocket formation, sites with thin biotypes had a tendency to redness and gingival recession, with underlying bone undergoing a rapid bone loss associated with the tissue recession [4]. Following surgery, sites with thick biotype showed predictable healing while those with thin gingival biotypes had less predictable healing [4]. After tooth extraction, sites with thick phenotypes showed minimal ridge atrophy while sites with thin biotypes showed significant alveolar ridge resorption in the apical and lingual direction [4]. During implant treatment planning it is therefore essential that the biotype present around hopeless teeth that will potentially be replaced with dental implants would be identified so that modifications can be made in order to prevent potential tissue loss (Figures 6-10).



Figure 6: Surgical extraction and immediate implant in patient with thin gingival phenotype.

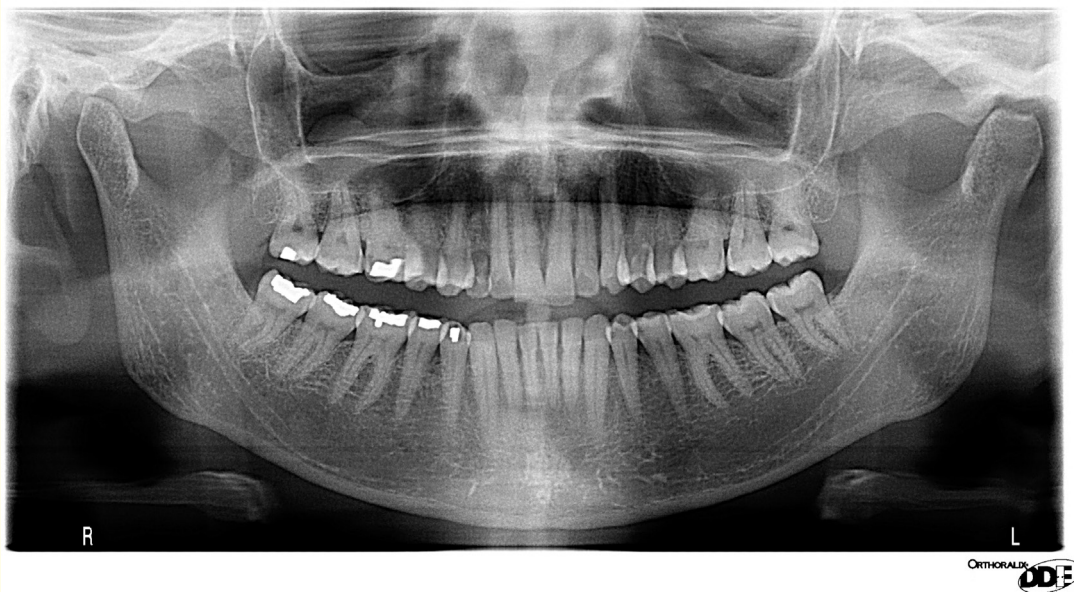


Figure 7: Before extraction x-rays.



Figure 8: Extraction.



Figure 9: Dental implant in place.



Figure 10: Temporary in place to contour soft tissue.

Methods of assessing gingival phenotype

A number of studies have detailed methods to assess gingival phenotype including visually or directly measuring the site with a periodontal probe with measures of > 1.5 mm considered thick biotype and < 1.5 mm regarded as thin, the direct visual probing method presents concerns regarding reproducibility amongst different examiners and is not a reliable measure of gingival biotype [5]. Another technique involves the Trans method advocated by De Rouck., *et al.* which involves assessing probe transparency through the gingival sulcus, the probe is not visible if placed 1 mm into the sulcus for tissue with thick biotypes, but is visible when placed 1 mm into the gingival sulcus for thin phenotypes [2]. With the Trans method, there was a high reproducibility and 85% inter-examiner repeatability it is therefore recommended for assessing gingival biotype [1,6].

Other methods of assessing gingival phenotype involve the use of ultrasonic devices, despite having been found to have a 95% repeatability between examiners, the equipment is very expensive and it is often difficult to be able to correctly position the device, it is therefore not used routinely to assess phenotype [1]. Use of cone beam x-rays are an objective way to evaluate bone and soft tissue thickness and has shown high accuracy and reproducibility in ability to identify types of phenotypes the only drawback is the cost of the cone beam x-ray machine [1].

Effect of gingival phenotype on healing around dental implants

Bhat., *et al.* conducted a study to evaluate the influence of gingival phenotype on dental implant healing for implants placed in patients that had thick versus thin gingival phenotypes and found that for patients that had thick phenotypes following implant placement to second stage there was mild loss of soft tissue and marginal bone compared to significant amount of loss that occurred in patients with thin gingival phenotypes [7]. They also found that after implant restoration cementation, there was a significant rebound of soft tissue and marginal bone around implants with thick gingival phenotypes, at six months (2.44 mm increase) and also at 12 months (3.22 mm

increase) while only a gradual rebound occurred for patient with thin phenotype at 6 months (1.13 mm) and at 12 months (1.59 mm) [7]. Based on their findings they advocate conversion from thin to thick phenotypes prior to dental implant placement to ensure adequate marginal bone and soft tissue healing and overall implant success [7].

Bhusari, *et al.* evaluated the clinical effect on thin biotype on successful surgical and implant placement and noted that areas of the mouth that had thin gingival tissue were most prone to break down and experienced attachment loss after periodontal surgery while those with thick tissue biotype did not [8]. In assessing sites following dental implant placement, they found that sites with thin biotype had increased recession and were more prone to marginal bone loss and angular defects compared to sites with thick phenotypes which did not have bone loss [8]. During tooth extraction sites with thin biotype were also found to be more prone to buccal plate fracture and loss of labial bone while sites with thicker gingival biotypes were more resistant [8]. The goal when treatment planning hopeless teeth with thin phenotypes for extraction involves atraumatic extractions which combine either bone preservation techniques or ridge augmentation, as well as use of soft tissue grafts to convert thin phenotypes to thick gingival phenotypes.

As an explanation for the dramatic loss of bone and soft tissue that happens after dental implant therapy in sites with thin gingival tissue, Atsuka, *et al.* performed an *in vivo* study of implant soft tissue seal and noted that it was composed of oral sulcular epithelium, peri-implant epithelium and peri-implant sulcular epithelium, they noted that only the peri-implant epithelium directly contacted the body of the implant, and unlike the perpendicular orientation of connective tissue fibers around teeth, the connective tissue seal around dental implants was parallel in nature making it less resistant and also more permeable to bacterial insult [9]. As a result when the phenotype is thin, the peri-implant seal is more permeable to bacteria, sites with thin phenotype are also more susceptible to gingival recession due to having fewer blood vessels that do not adequately support gingival tissue formation around dental implants [9]. Suarez-Lopez, *et al.* confirmed using meta-analysis that tissue thickness of > 2 mm was required around dental implants in order to effectively establish biologic width, they also indicated that implant sites with less than 2mm thickness tended to show an increase in marginal bone loss over time [10] (Figure 11-14).



Figure 11: Immediate Implant placement in patient with thick gingival phenotype.



Figure 12: X-ray of tooth for implant placement.

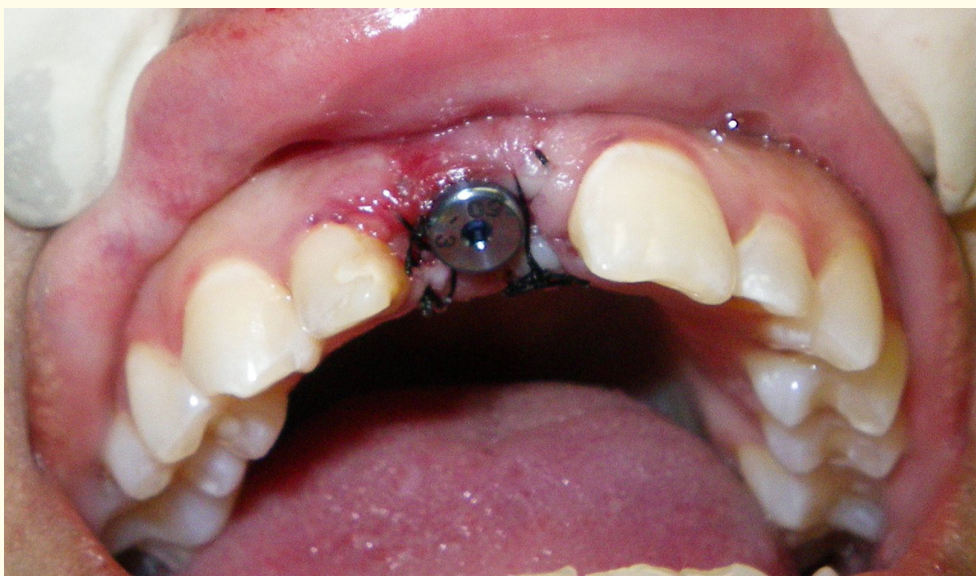


Figure 13: Healing abutment.



Figure 14: Implant restoration showing thick gingival phenotype that masks restorative components.

Treatment planning sites with thin phenotypes for dental implants and methods to change to thick phenotype

The most important factors affecting soft tissue contour are implant position and biotype [11]. As a result when treatment planning maxillary implants in adequate to correct position on all dimensions, it is essential that when a thin phenotype exists it is corrected to prevent esthetic failures that can occur from having adequate soft tissue around the implant and restoration such as metal showing through gingival tissue, soft tissue recession, loss of marginal bone around the implant, and also loss of interdental papilla.

When treatment planning dental implants in the esthetic zone for teeth that have been noted to have thin gingival biotype and minimal attached gingiva, modifications such as using a staged approach with extraction and socket preservation, followed by implant placement months after healing be performed to allow for formation of soft tissue contours as well as time to complete soft tissue augmentation procedures when necessary [12]. Deeb, *et al.* advocate avoidance of immediate implant placement in the anterior zone if there is thin biotype and opting for the delayed technique, or performing soft tissue grafting at time of immediate implant placement often combined with a provisional restorations to help contour the soft tissue in preparation for a permanent restoration [12] (Figure 15-19).

Other recommendations include the use of free gingival grafts to increase keratinized tissue around implants, with the goal of creating a tighter seal of dense tissue around the implant that is less permeable [13,14]. Thoma, *et al.* noted that soft tissue procedures that improved the keratinized tissue around dental implants resulted in improvement of bleeding and gingival indices. They also found that as soft tissue thickness increased, marginal bone loss was decreased [15]. Schrott, *et al.* found that there was an association between keratinized tissue width, and that sites with thin keratinized tissue had a tendency to have higher bleeding and gingival indices, primarily on the lingual surfaces around dental implants [16].



Figure 15: Initial present of patient with thin biotype requiring immediate dental implants



Figure 16: Implant in place.



Figure 17: Temporary restoration to contour soft tissue.



Figure 18: Final restoration.

Kadkhodazadeh, *et al.* suggested a protocol for soft tissue management around dental implants involving performing procedures to regain adequate keratinized tissue thickness and width prior to dental implant placement and ensuring adequate bone and soft tissue thickness has been achieved prior to proceeding with dental implants [17].

Chiu, *et al.* evaluated the significance of width of keratinized tissue on peri-implant health and found that in the presence of thin keratinized tissue, implant sites in patients with poor oral hygiene showed increased bleeding and gingival indices. They indicated that keratinized tissue is helpful with creating a favorable environment for oral hygiene around dental implants while mucosal tissue is usually movable and can impede adequate performance of oral hygiene around dental implants [18].

Baltacioglu, *et al.* assessed the effect of using peri-implant plastic surgery procedures to increase keratinized tissue around dental implants and found that after grafting procedures were done that increased keratinized tissue to more than 2 mm, peri-implant health was maintained for a period of 6 months to 4 years [19]. They indicated that when adequate keratinized tissue exists at the implant soft tissue border this facilitates a tight tissue adaptation and marginal seal at the implant surface that provides connective tissue fiber system that is resistant to mechanical stress and facilitates oral hygiene procedures [19].

Ioannou, *et al.* made recommendations that soft tissue grafts when used to increase gingival thickness could be done at time of implant placement, during second stage surgery or as a rescue procedure for sites with soft tissue related esthetic concerns such as metal showing through or when there is a need for the tissue in the implant site to better harmonize with that of adjacent teeth [13].

Conclusion

Gingival phenotype has a major impact on soft tissue healing and marginal bone loss around dental implant sites as a result evaluating it is a major part of implant pre-treatment assessment especially in the anterior maxilla where soft tissue contours that are continuous with adjacent natural teeth are critical for esthetic success. For sites that have thin phenotype the goal to make modifications in planning to include bone grafts for ridge preservation and augment soft tissue to improve tissue thickness. Other modifications include use of delayed implant placement to allow complete bone and soft tissue healing prior to dental implant placement and the use of soft tissue grafts with immediate implant placement to enhance soft tissue thickness. Although the impact of increasing keratinized tissue around dental implants is still being studied, a number of studies found that it is able to improve gingival indices around dental implants especially in patients with deficient oral hygiene.

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