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A Narrative Review on Etiology, Pathogenesis and Therapeutic Strategies in Management of Gingival Pigmentation

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ABSTRACT: A beautiful smile defines the facial aesthetics and has a positive psychological impact on the individual. It is governed by the harmonious balance between the pink and white esthetics. The color of the gingiva is physiologically attributed by the melanin pigmentation. The degree of pigmentation depends on various factors including the ethnicity. Gingival depigmentation is an esthetic procedure that reduces the intensity of the melanin pigmentation using various surgical and non-surgical techniques. This narrative review will discuss the etiopathogenesis of gingival pigmentation and various gingival depigmentation techniques, critically analyzing its indication, advantages and disadvantages. Numerous databases, including PubMed, Google Scholar, and Google Search, were reviewed. The search method employed combined phrases like “Smile esthetics,” “Gingival pigmentation,” “Gingival depigmentation,” “gingival peeling,” “Laser assisted gingival depigmentation,” and “oral mesotherapy.” This search results gathered and analyzed 36 distinct academic publications. According to the study’s findings, gingival pigmentation can be either a physiological condition caused due to melanin pigmentation or can be due to underlying systemic disease condition. Various surgical, chemical, non-surgical and minimally invasive techniques have been scientifically tested and proved to reduce the intensity of pigmentation. The selection of the appropriate gingival depigmentation technique depends on holistically considering the individual’s skin tone, extent, severity, gingival architecture, phenotype and biotype. Depigmentation is performed only if it’s of esthetic concern to the subject. These procedures are highly technique sensitive and depend on the clinician’s skill to perform the appropriate technique which is cost effective and cause minimal discomfort to the individuals.

1. INTRODUCTION

Smile is the most powerful tool of human expression that enhances self-confidence. A beautiful smile is a result of balance between the pink and white esthetics (Grover et al., 2014). Pink esthetics is governed by the color, contour, shape and position of the gingiva, while the white esthetics focus on the shape, color, translucency of the teeth (Merchant et al., 2022). It serves as an elegant framework that harmonizes the teeth. Gingiva plays a pivotal role in sculpting a smile into a symmetrical and beautiful masterpiece. The ideal color of the gingiva is coral pink but it is governed by various factors. The Gingival color primarily depends on the degree of keratinization, thickness of the gingival epithelium, vascularity of the underlying connective tissue and the presence of certain pigment forming cells in the epithelium. Primarily, the pigments contributing to the color of the oral mucosa includes melanin, carotene, reduced and oxy-hemoglobin (Fiorellini et al., 2009). The gingival pigmentation varies from mild brown to black depending on various factors.

The factors contributing to the gingival pigmentation may involve endogenous and exogenous factors. The most common endogenous factor that attributes to the gingival color is the non-hemoglobin derived melanin pigment, produced by melanocytes (Adel Kauzman et al., 2004). Melanocytes constitutes a heterogenous unicellular dendritic cell that resides in the

basal layer of oral epithelium. The only sign of pigmentation in the body that appears as early as 3 hours after birth is the melanin pigmentation in the oral tissue. The close relationship of melanocyte with keratinocytes is known as 'epidermal melanin unit' (Sanjeevini et al., 2012).

2. ETIOLOGY OF GINGIVAL PIGMENTATION:

Based on the etiology, gingival pigmentation can be broadly classified into physiologic or pathologic. Physiologic gingival pigmentation caused by the melanin pigments will be present in all individuals excluding the albinos. It usually develops during the first two decades of life, is asymptomatic and doesn't require any treatment (Moneim et al., 2017). The degree of melanin pigmentation in the gingiva varies among individuals based on their ethnicity relating to their skin pigments. Clinically the pigmentation may appear diffuse or multifocal due to varying degree of melanocyte activity rather than the number of melanocytes (Adel Kauzman et al., 2004). The process of melanin production by the melanocyte involves three phases, 1) melanocyte activation – various factors like sunlight or stress induces synthesis of chemical messengers like melanocyte stimulating hormone that activates melanocytes; 2) melanin synthesis – tyrosinase enzyme initiates the conversion of tyrosine into dehydroxyphenylalanine which further breaks down into dopaquinone, which is converted into dark melanin called eumelanin or light melanin known as pheo-melanin; 3) melanin expression – the pigment is transferred from melanocytes into the keratinocyte resulting in epithelial pigmentation (Lerner et al., 1950).

The pathological gingival pigmentation is caused either due to endocrine disorders like Addison's disease, Albright's syndrome, Nelson's syndrome or heavy metal exposure like lead, bismuth, mercury, arsenic, silver, gold or malignant conditions like Kaposi sarcoma or can be drug induced due to medications like chloroquine, minocycline and zidovudine (Adel Kauzman et al., 2004). Other factors that can cause pathological pigmentation includes smoking associated melanosis, hemangioma, amalgam tattoo and melanomas (Anders Hedin et al., 1987).

Dummett in 1979 defined gingival hyperpigmentation as the excessive deposition of melanin pigment in the supra-basal and basal layers of the gingival epithelium (Patil et al., 2015). Excessive gingival pigmentation is of a major aesthetic concern for many individuals especially with gummy smile or if there is significant mismatch between the skin and the gingival pigmentation.

3. CLASSIFICATION OF GINGIVAL HYPERPIGMENTATION:

Numerous classification systems are used for categorizing pigmented lesions of oral cavity. Gingival pigmentation is classified based on the etiology, extent and severity. The most commonly used (DOPI) Oral pigmentation index was proposed by Dummett in 1964 (Dummett & Gupta 1964). Numerical pigmentation score ranging from 0 to 3 will be given based on the extent and severity of pigmentation following which it is classified into Mild, Medium and Heavy (Dummett et al., 1964). Gingival melanin pigmentation and pigmented lesions index was proposed by Peeran et al in 2014. The pigmentation is scored from 0 to 10 based on etiology and distribution (Peeran et al., 2014).

3. GINGIVAL DEPIGMENTATION:

It is a periodontal - plastic surgical procedure that involves reduction or removal of gingival hyperpigmentation by various techniques is called as gingival depigmentation (Malhotra et al., 2011). The treatment is indicated when there is an esthetic concern or if desired by the patient (Grover et al., 2014; Elavarasu et al., 2015). The treatment planning for gingival pigmentation should also consider the etiological factors. Various treatment options like surgical techniques, chemical methods, electrosurgery, cryosurgery and lasers are available for reduction of pigmentation. The selection of the appropriate technique should consider certain criteria involving patient's skin tone, extent/ severity of pigmentation, lip line, lip curvature, patient's esthetic concern and outcome expected from the treatment (Grover et al., 2014; Dummett & Gupta 1964; Malhotra et al., 2011). The other factors to be considered are the simplicity, cost effectiveness and minimal discomfort during the procedure (Sharath et al., 2013). Clinician should be cautious in avoiding any damage to the underlying periodontium or damage to the attachment apparatus.

3.1 Gingival abrasion:

Ginwalla et al in 1966 documented gingival abrasion technique, which involves denudation and superficial abrasion of the gingival epithelium using doughnut shaped coarse diamond burs (Ginwalla et al., 1966). The procedure is performed using a low-speed handpiece, so that it does not cause any untoward abrasion or pitting of the tissue. It is considered relatively non-

invasive and cost effective, but it is highly technique sensitive. Post-operative discomfort and high recurrence rate are the major drawbacks for this technique (Kumar et al., 2012).

3.2 Conventional scalpel technique:

Conventional scalpel technique, also known as surgical stripping, involves surgical excision of the pigmented gingival epithelium using scalpel and exposing the connective tissue which is allowed to heal by secondary intention (El-Shenawy et al., 2017). (Figure 1) This technique is simple, less technique sensitive, less time consuming and cost effective. Healing and post-surgical outcome is faster and better than other techniques. Even though the rate of recurrence is less, post-operative pain, discomfort, intra & post-operative bleeding are the major drawbacks associated with scalpel technique. This technique is contraindicated in subjects with thin gingival biotype and with narrow interpapillary spaces (Bergamaschi et al., 1993).



Figure 1: Conventional Scalpel technique: (a) Pre-operative image with diffuse gingival pigmentation, (b) De-epithelialization using scalpel, (c) 6 month follow up

3.3 Free gingival graft:

A free gingival autograft is harvested from the unpigmented palatal mucosa and placed on the surgically prepared (de-epithelialized) recipient site (Tamizi and Taheri 1996). The drawbacks of this techniques include post-operative discomfort due to two surgical sites and color mismatch in the recipient site, also known as ghost like appearance due to hypopigmentation. Despite its drawbacks, this technique can be considered as an alternative in individuals with thin gingival biotype (Kumar et al., 2012).

3.4 Acellular dermal matrix allograft:

Acellular dermal matrix allograft is considered as an alternative to free gingival autograft to treat gingival hyperpigmentation. This technique eliminates the need for second surgical site, thereby reduces the post-operative complications like pain and bleeding (Kathariya and Pradeep 2011; Novaes et al., 2002). However, it is technique sensitive, expensive and requires clinical expertise (Kathariya and Pradeep 2011).

3.5 Electrosurgery:

Electrosurgery technique is performed by transmission of high-frequency electrical energy to the gingival tissues resulting in heat generation, which either cut or coagulate the target tissue (Prasad et al., 2010). Advantages of using this technique includes minimal bleeding in the surgical site and adequate tissue contouring with minimal scar formation (Gupta et al., 2015). However, post-operative pain and discomfort during the initial stages of healing is considerably higher with this technique. It is highly technique sensitive, because prolonged or repeated heat application may result in heat accumulation and results in damage to

underlying periodontium, especially if the electrocautery tip comes in contact with the periosteum or alveolar bone (Moneim et al., 2017).

3.6 Cryosurgery:

This technique involves freezing the gingiva with materials like cryogen (liquid nitrogen). It works on the principle of rapid freezing of the tissue, followed by slow melting resulting in thermal shock induced protein denaturation and epithelial cryo-necrosis. The major advantage of this technique is that it can be performed without anesthesia and cause minimal bleeding or scar formation in surgical site (Kumar et al., 2012). The duration of freezing has not been optimized; hence the depth of penetration cannot be controlled causing increased soft tissue destruction (Javali et al., 2011). Literature reports considerable post-operative swelling following the use of cryosurgery and is considered as a major drawback (Prasad et al., 2010; Almas and Sadig 2002).

3.7 LASER:

Laser assisted Gingival depigmentation (Figure 2) is considered as an efficient, successful and reliable minimally invasive technique (Prabhuji et al., 2011). Laser works by the principle of tissue ablation and absorption by the light absorbing chromophores like melanin, causing irreversible damage to melanocytes, resulting in reduction of melanin pigmentation. Diode laser is the most effective and frequently used technique. Systematic review and meta-analysis by Gul et al in 2019 and Jazzar et al in 2023, suggest that diode laser assisted depigmentation is equally effective than the conventional surgical technique due to its better esthetic outcome, low recurrence rate, less post-operative pain, reduced bleeding, quick healing and hence improved patient satisfaction (Gul et al., 2019; Jazzar and AlDehlawi 2023). Drawbacks of this technique includes delayed epithelial regeneration, requirement of sophisticated instruments and is considered highly technique sensitive (Kumar et al., 2013).

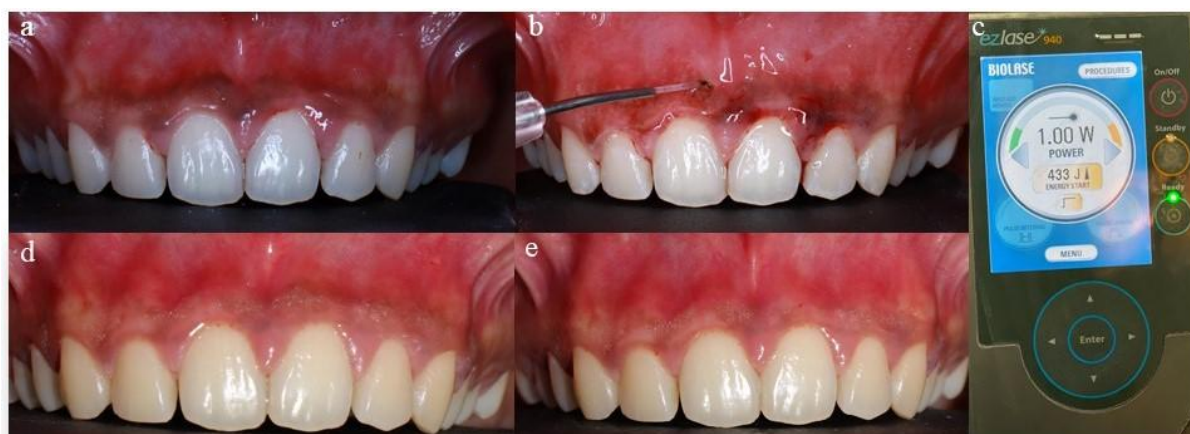


Figure 2: Laser assisted gingival depigmentation (a) Pre-operative image with diffuse gingival pigmentation, (b,c) Depigmentation using 940nm diode laser, (d) 1 month follow up, (e) 6 month follow up

3.8 Chemical gingival peeling:

The method destroys the gingival epithelium using chemical peeling agents like phenols and alcohols (Herschfeld et al., 1951). The major drawback of this technique includes high recurrence rate, inability to control the depth of penetration or the amount of destruction and require cardiac monitoring because phenols may induce cardiac arrhythmias (Kathariya and Pradeep 2011). Hence this technique is no longer recommended by the clinicians.

3.9 Ascorbic acid/ Vitamin C:

Vitamin C or ascorbic acid inhibits melanin biosynthesis by suppressing tyrosine activity and also by directly downregulating dopaquinone formation (Shimada et al., 2009). Topical application of Vitamin C gel has been used as an adjunctive to surgical depigmentation and was proved to reduce the rate of recurrence at 9 month follow up (Sheel et al., 2015). Oral mesotherapy technique is considered as minimally invasive because the technique involves sub epithelial deposit of vitamin C using micro needle. (Figure 3) Oral mesotherapy using Vitamin C showed better and early effects when compared to topical application. It shows promising results with improved patient-related outcome like no pain, less discomfort, no disruption to daily activities

and is also cost effective (El-Mofty et al., 2011). The only drawback of this technique is that it requires multiple visits to the dentist (Ashokkumar et al., 2024).



Figure 3: Oral Mesotherapy using Vitamin C: (a) Pre-operative image with diffuse gingival pigmentation, (b,c) sub-epithelial administration of vitamin C, (d) 1 month follow up, (e) 6 month follow up

4. CONCLUSION:

The discoloration of the gingiva could be due to physiological reason like ethnicity or manifestation of systemic conditions. Hence the treatment planning for gingival pigmentation should also consider the etiological factors. Gingival hyperpigmentation is not considered as a major complication, but it is of high esthetic concern. Various treatment options are available to reduce or remove the pigmentation. The choice of the treatment should take into consideration the medical history, etiology, patient's esthetic demand, duration of the treatment, patient compliance, cost incurred for the procedure, recurrence rate and the clinician's expertise to effectively manage the condition.

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AUTHOR CONTRIBUTIONS

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Lekha Ashokkumar: Conceptualization, Writing—Review & Editing.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS STATEMENT

Ethical approval was not required for this study.

DATA AVAILABILITY STATEMENT

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

- [1] Adel Kauzman, B.D.S., Pavone, M., Blanas, N. and Bradley, G., 2004. Pigmented lesions of the oral cavity: review, differential diagnosis, and case presentations. *J Can Dent Assoc*, 70(10), pp.682-3. <https://pubmed.ncbi.nlm.nih.gov/15530266/>
- [2] Almas, K. and Sadig, W., 2002. Surgical treatment of melanin-pigmented gingiva; an esthetic approach. *Indian journal of dental research: official publication of Indian Society for Dental Research*, 13(2), pp.70-73.
- [3] Anders Hedin, C. and Larsson, Å., 1987. Large melanosome complexes in the human gingival epithelium. *Journal of periodontal research*, 22(2), pp.108-113. <https://doi.org/10.1111/j.1600-0765.1987.tb01548.x>
- [4] Ashokkumar, L., Krishnakumar, D., Ravindran, D.M., Jain, S., Kumar, D. and Sk, B., 2024. Comparison of Various Minimally Invasive Techniques for the Management of Gingival Hyperpigmentation: A Case Report. *Cureus*, 16(11). <https://doi.org/10.7759/cureus.73870>
- [5] Bergamaschi, O., Kon, S., Doine, A.I. and Ruben, M.P., 1993. Melanin repigmentation after gingivectomy: a 5-year clinical and transmission electron microscopic study in humans. *International Journal of Periodontics & Restorative Dentistry*, 13(1), p.84.
- [6] Dummett, C.O. and Gupta, O.P., 1964. Estimating the epidemiology of oral pigmentation. *Journal of the national medical association*, 56(5), p.419.
- [7] Elavarasu, S., Thangavelu, A. and Alex, S., 2015. Comparative evaluation of depigmentation techniques in split-mouth design with electrocautery and laser. *Journal of pharmacy & bioallied sciences*, 7(Suppl 2), p.S786. <https://doi.org/10.4103/0975-7406.163563>
- [8] El-Mofty, M., Elkot, S., Ghoneim, A., Yossri, D. and Ezzatt, O.M., 2021. Vitamin C mesotherapy versus topical application for gingival hyperpigmentation: a clinical and histopathological study. *Clinical oral investigations*, 25(12), pp.6881-6889. <https://doi.org/10.1007/s00784-021-03978-6>
- [9] El-Shenawy, H., Fahd, A., Ellabban, M., Dahaba, M. and Khalifa, M., 2017. Lasers for esthetic removal of gingival hyperpigmentation: A systematic review of randomized clinical trials. *Int J Adv Res*, 5(3), pp.1238-48. <https://doi.org/10.21474/IJAR01/3629>
- [10] Fiorellini JP, Kim DM, Ishikawa SO., 2009. The gingiva. Carranza's clinical periodontology-10th edition, 4:(46-67).
- [11] Ginwalla, T.M., Gomes, B.C. and Varma, B.R., 1966. Surgical removal of gingival pigmentation.(A preliminary study). *Journal of the Indian Dental Association*, 38(6), pp.147-50.
- [12] Grover, H.S., Dadlani, H., Bhardwaj, A., Yadav, A. and Lal, S., 2014. Evaluation of patient response and recurrence of pigmentation following gingival depigmentation using laser and scalpel technique: A clinical study. *Journal of Indian Society of Periodontology*, 18(5), p.586. <https://doi.org/10.4103/0972-124x.142450>
- [13] Gul, M., Hameed, M.H., Nazeer, M.R., Ghafoor, R. and Khan, F.R., 2019. Most effective method for the management of physiologic gingival hyperpigmentation: A systematic review and meta-analysis. *Journal of Indian Society of Periodontology*, 23(3), p.203. https://doi.org/10.4103/jisp.jisp_555_18
- [14] Gupta, N.D., Agrawal, A., Agrawal, N. and Yadav, P., 2015. Gingival depigmentation by different technique: A case series. *IOSR J Dent Med Sci*, 14(12), p.93e7. <https://doi.org/10.9790/0853-141279397>
- [15] Hirschfeld, I. and Hirschfeld, L., 1951. Oral pigmentation and a method of removing it. *Oral Surgery, Oral Medicine, Oral Pathology*, 4(8), pp.1012-1016. [https://doi.org/10.1016/0030-4220\(51\)90448-3](https://doi.org/10.1016/0030-4220(51)90448-3)
- [16] Javali, M., Tapashetti, R. and Deshmukh, J., 2011. Esthetic management of gingival hyperpigmentation: report of two cases. *International Journal of Dental Clinics*, 3(2), pp.115-116.
- [17] Jazzar, A. and AlDehlawi, H., 2023. Efficacy and risks of different treatments for oral hyperpigmentation: a systematic review and network meta-analysis. *Journal of clinical medicine*, 12(20), p.6567. <https://doi.org/10.3390/jcm12206567>

- [18] Kathariya, R. and Pradeep, A.R., 2011. Split mouth de-epithelization techniques for gingival depigmentation: A case series and review of literature. *Journal of Indian Society of Periodontology*, 15(2), p.161. <https://doi.org/10.4103/0972-124X.84387>
- [19] Kumar, S., Bhat, G.S. and Bhat, K.M., 2012. Development in techniques for gingival depigmentation—An update. *Indian journal of dentistry*, 3(4), pp.213-221. <https://doi.org/10.1016/j.ijid.2012.05.007>
- [20] Kumar, S., Bhat, G.S. and Bhat, K.M., 2013. Comparative evaluation of gingival depigmentation using tetrafluoroethane cryosurgery and gingival abrasion technique: two years follow up. *Journal of clinical and diagnostic research: JCDR*, 7(2), p.389. <https://doi.org/10.7860/JCDR/2013/4454.2779>
- [21] Lerner, A.B. and Fitzpatrick, T.B., 1950. Biochemistry of melanin formation. *Physiological reviews*, 30(1), pp.91-126. <https://doi.org/10.1152/physrev.1950.30.1.91>
- [22] Malhotra, S., Khuller, N., Sharma, N. and Basavaraj, P., 2011. Gingival esthetics by depigmentation. *Journal of Indian Association of Public Health Dentistry*, 9(Suppl 2), pp.S611-S615.
- [23] Merchant, A., Maiti, S., Rajaraman, V., Velayudhan, A. and Ganapathy, D.M., 2022. Comparative analysis of pink and white esthetics of anterior full veneer crown: Indian scenario. *Journal of Advanced Pharmaceutical Technology & Research*, 13(Suppl 1), p.S282. https://doi.org/10.4103/japtr.japtr_214_22
- [24] Moneim, R.A.A., El Deeb, M. and Rabea, A.A., 2017. Gingival pigmentation (cause, treatment and histological preview). *Future Dental Journal*, 3(1), pp.1-7. <https://doi.org/10.1016/j.fdj.2017.04.002>
- [25] Moneim, R.A.A., El Deeb, M. and Rabea, A.A., 2017. Gingival pigmentation (cause, treatment and histological preview). *Future Dental Journal*, 3(1), pp.1-7. <https://doi.org/10.1016/j.fdj.2017.04.002>
- [26] Novaes Jr, A.B., Pontes, C.C., Souza, S.L., Grisi, M.F. and Taba Jr, M., 2002. The use of acellular dermal matrix allograft for the elimination of gingival melanin pigmentation: case presentation with 2 years of follow-up. *Practical procedures & aesthetic dentistry: PPAD*, 14(8), pp.619-23.
- [27] Patil, K.P., Joshi, V., Waghmode, V. and Kanakdande, V., 2015. Gingival depigmentation: A split mouth comparative study between scalpel and cryosurgery. *Contemporary clinical dentistry*, 6(Suppl 1), p.S97. <https://doi.org/10.4103/0976-237X.152964>
- [28] Peeran SW, Ramalingam K, Peeran SA, Altaher OB, Alsaid FM, Muqrabi MH. Gingival pigmentation index proposal of a new index with a brief review of current indices. *European journal of dentistry*. 2014 Apr;8(02):287-90. <https://doi.org/10.4103/1305-7456.130640>
- [29] Prabhuji, M.L., Madhupreetha, S.S. and Archana, V., 2011. Treatment of gingival hyperpigmentation for aesthetic purposes using the diode laser. *Int Mag Laser Dent*, 3(2), pp.18-9.
- [30] Prasad, S.S., Agrawal, N. and Reddy, N.R., 2010. Gingival depigmentation: A case report. *People's J Sci Res*, 3(1), pp.27-29.
- [31] Sanjeevini, H., Pudakalkatti, P., Soumya, B.G. and Nayak, A., 2012. Gingival de-pigmentation: 2 case reports. *World J Med Pharm Biol Sci*, 2, pp.01-4.
- [32] Sharath, K.S., Shah, R., Thomas, B., Madani, S.M. and Shetty, S., 2013. Gingival depigmentation: Case series for four different techniques. *Journal of Health and Allied Sciences NU*, 3(04), pp.132-136. DOI: 10.1055/s-0040-1703720
- [33] Sheel, V., Purwar, P., Dixit, J. and Rai, P., 2015. Ancillary role of vitamin C in pink aesthetics. *BMJ Case Reports CP*, 2015, p.bcr2014208559. <https://doi.org/10.1136/bcr-2014-208559>
- [34] Shimada, Y., Tai, H., Tanaka, A., Ikezawa-Suzuki, I., Takagi, K., Yoshida, Y. and Yoshie, H., 2009. Effects of ascorbic acid on gingival melanin pigmentation in vitro and in vivo. *Journal of periodontology*, 80(2), pp.317-323. <https://doi.org/10.1902/jop.2009.080409>
- [35] Tamizi, M. and Taheri, M., 1996. Treatment of severe physiologic gingival pigmentation with free gingival autograft. *Quintessence international*, 27(8), p.555.