LASERS FOR ESTHETIC REMOVAL OF GINGIVAL HYPERPIGMENTATION: A SYSTEMATIC REVIEW OF RANDOMIZED CLINICAL TRIALS.

Hanaa El-Shenawy¹, Ali Fahd²*, Mohamed Ellabban³, Mushira Dahaba⁴ and Mohamed Khalifa⁴.
1. Oral Surgery and Medicine Department, National Research Centre, Egypt.
2. Oral and Maxillofacial Radiology department, Faculty of oral and dental medicine, South Valley University, Egypt.
3. Orthodontic department, Faculty of oral and dental medicine, Assiut University, Egypt.
4. Oral and Maxillofacial Radiology Department, Faculty of Oral and Dental Medicine, Cairo University, Egypt.

Abstract

Background: Being a science of beauty, beautiful smile is an integral part of contemporary dental practice. Gingival hyperpigmentation is considered an esthetic problem that needs a patient centered management. Dental operators are attracted to laser benefits not only during surgery but also for postoperative status. This review aimed to assess laser use in esthetic removal of gingival hyperpigmentation in comparison to conventional methods.

Materials and Methods: An electronic database search on PubMed and Cochrane library without date restriction was done and clinical studies in which laser was used for esthetic gingival depigmentation were selected and evaluated. Out of the initial search that yielded 183 studies, 21 were considered potentially relevant for the present review, out of which only 4 were finally selected. They studied the effect of laser on depigmentation, chair time, bleeding index, patient satisfaction and repigmentation.

Results: The analysis of the results shows that the assessed studies are too limited in number beside exhibiting small sample sizes. They are clinically heterogeneous so that a solid evidence based conclusion cannot be reached.

Conclusion: Researchers should be attracted to this research gap. Randomized clinical trials with a larger sample size, different laser parameters and longer follow up are strongly recommended.

Corresponding Author:- Ali Fahd Fadel
Oral and Maxillofacial Radiology department, Faculty of oral and dental medicine, South Valley University, Qena, Egypt.

Introduction:-

Being a science of beauty, beautiful smile is an integral part of contemporary dental practice. Good smile involves not only teeth shape and color but also the gingival status. Pink gingival color is more favorable than dark one. Melanin hyperpigmentation or darker gingival color can be considered an aesthetic concern rather than a medical problem (Basha et al. 2015).
Dentists should be prepared with the latest evidence based practice for management of such cases. The selection of technique should be based not only on clinical experience and doctor preferences but also on patient preferences (Thangavelu et al. 2012). Various methods can be used with varied degrees of success (Roshna and Nandakumar 2005).

Gingival hyperpigmentation can be defined as a darker gingival color beyond what is normally expected. The most common cause is racial pigmentation while other causes includes physiologic and/or pathologic factors (Dummett and Baren 1967). Gingival depigmentation is the treatment aiming to remove the melanin hyperpigmentation and it can be done by several techniques including mechanical, surgical, electrosurgical, cryosurgical, free gingival grafts, and lasers (Ciccek and Ertas 2003, Hegde et al. 2013, Chandna and Kedige 2015). Surgical stripping was the old gold standard but now lasers have gained importance in the past years (Hegde et al. 2013, Basha et al. 2015).

A critical concern in the management of hyperpigmented gingiva is relapse or gingival repigmentation which can be defined as the reappearance of pigmentation after a period of no clinically hyperpigmentation. Recurrence usually varies according to the used methodology and the length of follow-up (Hegde et al. 2013).

The clinical rationale for comparing laser to conventional methods can be simply based upon the need for minimally invasive techniques for achieving a patient relevant outcomes (Ribeiro et al. 2014).

Based on this background, the aim of the present systematic review is to evaluate and compare the effects of conventional techniques versus lasers for gingival depigmentation as regards to removal of pigmentation, patient preference and time taken for repigmentation.

**Materials and Methods:-**

**Protocol:-**
The methods as well as inclusion/exclusion criteria used in the present study were determined in advance. The current systematic review was performed following the PRISMA guidelines for identification, screening, eligibility, and inclusion (Moher et al. 2010). The following focus question was developed: In patient requiring esthetic removal of gingival hyperpigmentation, is laser use recommended over conventional techniques, what is the evidence based recommendation for both patients and operators?

**Information Sources:-**
The electronic search was performed in two databases, MEDLINE (PubMed) and Cochrane library databases for articles with no date restrictions.

**Search:-**
The researched keywords were: (Black OR pigment OR melanin OR pigmentation OR hyperpigmentation OR pigmented OR dark OR Pigmentary OR pigmentation OR melanin) AND (Lased OR laser OR LLLT) AND (Gingiva OR mucosa OR gingival OR mucosal OR gum).

**Selection of studies:-**
Titles and abstracts resulted from the search were screened by authors considering the inclusion criteria. Authors decisions about choices and their qualification for further analysis was affirmed after discussion.

**Inclusion and exclusion criteria:-**

**Inclusion criteria:-**
- Randomized Clinical trials only
- Laser compared to conventional methods

**Exclusion criteria:-**
- Pigmentation due to amalgam tattoo, nevus or syndromes
- Case reports
- In vitro and animal studies
- Languages other than English
Assessment of methodological quality:-
The quality of all chosen randomized trials was investigated utilizing The Cochrane Collaboration's tool for evaluating risk of bias (Higgins et al. 2011).

According to Cochrane risk of bias tools, each RCT was assigned either; low risk of bias (if it is low for all key domains), high risk of bias (if it is high for one or more of key domains) and unclear risk of bias (if it is unclear for one or more of key domains). Because it was impossible to blind participants or personnel due to nature of intervention and control (i.e. Laser VS surgery), the “BLINDING OF PARTICIPANTS, PERSONNEL” item was not considered.

Results:-
Out of the initial search that yielded 183 studies, 21 were considered potentially relevant for the present study, out of which 4 were finally selected. Figure (1) represents the flow chart for the study. The excluded studies before final inclusion were uncontrolled or without conventional control (Trelles et al. 1993, Hanada et al. 1996, Nakamura et al. 1999, Ozbayrak et al. 2000, Tal et al. 2003, Esen et al. 2004, Azzeh 2007, Kaya et al. 2012, Giannelli et al. 2014, Kishore et al. 2014, Soliman et al. 2014, El Shenawy et al. 2015), review article (Karydis et al. 2011), uncontrolled case reports (Rosa et al. 2007, Bin Cho et al. 2010), non-randomized trial (Grover et al. 2014) and the study of Giannelli et al which was a thermographic and fluorescent study for optimizing gingival laser photoablation (Giannelli et al. 2013).

The final included studies were four (Hegde et al. 2013, Ribeiro et al. 2014, Basha et al. 2015, Chandna and Kedige 2015). The heterogeneity between trials prevented meta-analysis. Rather, a descriptive analysis of the reported studies was performed. Table (1) represents summary of findings.

Risk of bias within studies:-
The review included 4 studies, 3 studies (Hegde et al 2013, Ribeiro et al 2014, Basha et al 2015) used split mouth study design and 1 study (Chandna and Kedige 2015) used parallel design. Sex distribution was mentioned in 3 studies (Hegde et al 2013, Ribeiro et al 2014, Chandna and Kedige 2015) and not mentioned in 1 study (Basha et al 2015).

For RCT studies, according to Cochrane Risk of Bias Tool, all studies were judged as low risk of bias for incomplete outcome data, selective reporting and other bias. Regarding random sequence generation, 3 studies (Hegde et al 2013, Ribeiro et al 2014, Basha et al 2015) were judged as low risk of bias while it was judged as unclear for Chandna and Kedige 2015 study as it didn’t mention type of randomization used. Allocation concealment was unclear for all included studies. Regarding Blinding of outcome assessment, 3 studies (Hegde et al 2013, Basha et al 2015, Chandna and Kedige 2015) were judged as unclear as there was no any mention about blinding of the assessor or statistician while it was low risk of bias for Ribeiro et al 2014 study. All studies were considered overall as unclear risk of bias. Figure (2) represents risk of bias summary: review authors' judgements about each risk of bias item for each included RCT study while Figure (3) represents risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included RCT studies.
Figure 1: Prisma flow chart for the study.
**Figure 2:** Risk of bias summary: review authors' judgements about each risk of bias item for each included RCT study.

**Figure 3:** Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included RCT studies.
Discussion:
Lasers can be used as a contemporary alternative to the traditional scalpel in oral soft tissue surgeries because it offers simple manipulation as regards to absence of bleeding, reduced need for local anesthesia and increased patient comfort (Arnabat-Dominguez et al. 2010). From that points of view comes the research question, why not to recommend laser over conventional techniques.

Melanin is a word derived from the Greek one “melas” or black (Hegde et al. 2013). Melanin hyperpigmentation can affect all races and all ages with no gender predilection (Eisen 2000). Gingival hyperpigmentation is an esthetic problem for many patients, especially if visible when smiling. Lasers have been suggested as an alternative to conventional procedures for providing a more patient centered outcome (Atsawasuwon et al. 2000). However, up to date, no evidence based recommendation for whether to go for the conventional strategy or replace it with the contemporary lasers.

The trials presented in this review agreed that both techniques are successfully used for the treatment of gingival hyperpigmentation but which one is recommended over the other, an issue that needs further discussion.

Blade surgery for gingival depigmentation is a definite precise and controlled procedure beside being the most economical procedure. Any depigmented areas are appreciated immediately and there is no chance for any residual pigments. On the other hands, this technique required the use of local anesthesia, associated with pain and hemorrhage and required care not to expose the bone or create gingival recession (Grover et al. 2014).

Also, periodontal dressing for at least a week is mandatory to guard against food debris, foreign irritants, thermal stimuli and infection (Gurumoorthy Kaarthikeyan et al., Grover et al. 2014). The denuded tissues which heal by secondary intention after conventional surgery may promote bleeding after the procedure and is associated with some discomfort and pain for the patient (Ribeiro et al. 2014). The denuded connective tissue heals by secondary intention and is associated with pain and late repair (Roshna and Nandakumar 2005).

Table 1: Summary of findings table.

| Authors and date | Population | Laser type vs Control | Outcome |
|------------------|------------|-----------------------|---------|
| Basha et al 2015 | 20 patients with 40 bilateral maxillary sites | Nd: YAG laser vs Scalpel surgery | Intergroup comparison for time taken, pain, and patient preference was statistically significant in favor of laser. Intrigroup comparison for laser and surgical stripping at 6 months for Dummett Oral Pigmentation Index (DOPI), Hedin index, and size of pigmented area was statistically significant. Non-statistical difference in other results. |
| Hegde et al 2013 | 35 patients with 140 bilateral sites | CO2 and Er: YAG laser vs Scalpel surgery | Thorough removal of pigments, pain reduction, and higher patient preference were associated with Er: YAG laser but more sites showed repigmentation. The CO2 laser was beneficial in terms of complete hemostasis intraoperatively and delaying the rate of repigmentation. Repigmentation was least after the surgical stripping procedure. |
| Ribeiro et al 2014 | 11 patients with bilateral anterior maxillary sites | Nd: YAG laser vs Scalpel surgery | A statistically lesser chair time was observed in the laser group. A statistically lesser extent of discomfort/pain was in laser group during the first posttherapy week. Non-statistical difference in other results. |
| Chandna and Kedige 2015 | 20 patients (10 for each group) | Diode laser vs Electro-surgery | A statistically highly significant difference in the pain levels between the two groups 24 h post-operatively in favor of laser group. Despite of lesser mean pain level for the laser group at other times, it was a non-significant difference. |
The expected complicated postoperative period, even if mild, may interfere with patient daily activities and well-being (Ribeiro et al. 2014). An experience that should be avoided by the modern patient centered care strategy.

Despite that surgical stripping has been the old gold standard for gingival depigmentation, lasers start to gain prominence in that field (Coluzzi 2004).

Using of lasers for oral soft tissues provides benefits not only to dental operators but also for the patients. Patient-centered outcomes are the main target for researches in the last decade (Hujoel 2004, Ozcelik et al. 2007).

Concerning the cosmetic outcomes, some aspects of using lasers may benefit the purpose as precise cutting and control and the application of delicate contact tips during the procedure which enhances trans-operative visualization (Cobb 2006).

One of the advantages of using laser is that patients felt no pain either during or after the treatment without requiring an additional anesthetic injection. Fear of pain during dental surgeries or even the needle used for anesthesia are among the causes of avoiding dental visits. Thanks to lasers that solve a part of that problem (Matys and Dominiak 2016).

The reduced pain in comparison with conventional surgery may be due to the protein coagulum formed on the surface of the wound that acts as a biologic dressing. Sealing of the ends of sensory nerves may be also considered which is not the case in surgical stripping where the nerve endings is left exposed (Gurumoorthy Kaarthikkeyan et al. Hegde et al. 2013, Rathod and Mulay 2013, Basha et al. 2015). A disrupted cell membrane Na"-K" pump with the resulting loss of impulse conduction may be another cause of pain reduction associated with laser use (Chandna and Kedige 2015). The biologic dressing not only reduces pain but also protects the surgical area and provides a better postoperative repair with minimal damage to the tissue (Ribeiro et al. 2014).

Patients also appreciated the shorter operating time and minimal bleeding which is not the case in patients treated with the surgical scalpel technique (Hegde et al. 2013, Grover et al. 2014). The time taken for laser treatment was less than the surgical stripping where the nerve endings is left exposed (Cobb 2006).

Several studies have compared different lasers with varying results, similar advantages includes a relatively bloodless surgical field, minimal swelling and scarring, reduction of surgical time and less postoperative pain (Giannelli et al. 2014, Kishore et al. 2014, Soliman et al. 2014, Basha et al. 2015).

It is the ablative property of laser that makes it possible to be used for gingival depigmentation by targeting the melanin in melanocytes in epithelium which absorbs and converts light energy into heat or what is known as photothermolysis (Nakamura et al. 1999, Coluzzi 2004).

A variety of laser systems can be used for gingival depigmentation, including carbon dioxide (CO2) laser (Nakamura et al. 1999), diode laser (Kaya et al. 2012), Er:YAG laser (Kaya et al. 2012), and Nd:YAG laser (Atsawasuwan et al. 2000). Neodymium–yttrium aluminum garnet (Nd:YAG) laser treatment has been considered as an alternative for gingival hyperpigmentation because of rapid healing and minimal bleeding during and after the procedures (Ko et al. 2010). Fortunately, Nd:YAG laser is selectively absorbed by hyperpigmented tissues (Cobb 2006).

It is the inherent ability of diode lasers to be absorbed within the chromophores that allows controlled cutting with a limited depth of necrosis or by other words a tissue-specific ablation. The other advantage of diode laser is that its energy is transmitted through water and fortunately it is poorly absorbed in hydroxyapatite (Convissar 2004).

Low-power setting (≤2.5) is recommended during the procedure to avoid discomfort and pain during the postoperative period and for faster healing time. The gated pulsed mode is also recommended to provide the necessary thermal relaxation (Berk et al. 2005, Cercadillo-Ibarguren et al. 2010, Kaya et al. 2012, Romeo et al. 2012, Grover et al. 2014).
Esthetic gingival depigmentation is considered successful if there is delayed, minimal, or no repigmentation (Hegde et al. 2013). According to Bergamaschi et al., permanent results are non-achievable (Bergamaschi et al. 1993). Recurrence rate may differ not only with the used treatment modalities but also according to the duration of follow-up (Ribeiro et al. 2014).

Many studies reported recurrence after laser depigmentations (Bergamaschi et al. 1993, Nakamura et al. 1999, Esen et al. 2004, Rosa et al. 2007, Kaur et al. 2010) while others reported no repigmentation (Atsawasuwan et al. 2000, Tal et al. 2003, Azzeh 2007). Grover et al. reported that no statistical significance was seen in the comparison of conventional and laser techniques in terms of repigmentation (Grover et al. 2014).

It was noted that repigmentation appeared in the papillary areas and marginal gingiva which may be due to difficulty in treating these areas with lasers because of lying near tooth structure and the risk of thermal damage which recommends lower energy dose with inadequate depth of penetration of the laser beam, incomplete depigmentation, and faster recurrence (Hegde et al. 2013).

To avoid recurrence, the gingival tissue should be entirely cleared of melanin to avoid recurrence by melanocytes migration (Sharon et al. 2000). Also, patient race, environmental exposure exposure and smoking may play a role in repigmentation (Ünsal et al. 2001, Sridharan et al. 2011).

Interestingly, another aspect that may affect repigmentation is the number of performed laser sessions. All the studies that used multiple sessions for laser ablation reported no recurrence (Tal et al. 2003, Azzeh 2007, Kaya et al. 2012).

Also, repigmentation was more common in the maxillary arch in comparison to the mandibular arch which may be due to more exposure to environmental factors during smiling and speech, factors that are not related to the technique used (Hegde et al. 2013).

Laser biomodulation may be a double-edged weapon as while accelerating healing, melanocytes from adjacent areas migrate faster, leading to faster repigmentation (Hegde et al. 2013).

Laser application requires that the operators are trained about safe and effective use of lasers (Ribeiro et al. 2014). The surgical stripping gives the benefits of tactile sensation beside no risk of thermal damage to the underlying structures (Hegde et al. 2013).

It is important to mention that care should be taken not to injure the gingival margin and interdental papilla during ablation of pigmented gingival tissue in these delicate areas. Also, higher doses can cause like delayed wound healing promoted by severe coagulation or pain caused by uncontrolled carbonization (Ribeiro et al. 2014).

Laser requires more advanced technology and armamentarium and it causes higher financial costs than more economical scalpel technique (Ribeiro et al. 2014). The patients’ perceptions of costs and benefits balance interfere in the decision about choosing laser or scalpel surgical therapy.

The advantages of lasers over conventional surgical procedures are: bloodless field, reduced bacteremia and mechanical trauma, minimal post-operative swelling and scarring and minimal post-operative pain. On the other hand, loss of tactile sensation and expensive and sophisticated equipment that needs special training and precautions are considered disadvantages (Chandna and Kedige 2015).

**Conclusion:**
The found clinical studies are not only too limited in number but also exhibit small sample sizes, besides being clinically heterogeneous so that a solid conclusion cannot be reached. Researchers should pay attention to this interesting field to work upon. Each kind of laser application should pull attention of researchers in oral and maxillofacial field to close obvious, yet important, research gaps of lack of enough randomized clinical trials that can be relied upon to get a standard evidence based clinical practice.

Within the limitations of this review, it can be concluded that lasers can be used as a safer and effective treatment modality to provide optimal esthetics and enhanced comfort with lesser pain to the patients during the treatment for
gingival hyperpigmentation. However, surgical stripping is a cost-effective procedure for achieving gingival depigmentation. Higher patient preference and pain reduction favor laser depigmentation, but more sites showed repigmentation. The lower cost of surgical stripping and the lower rate for repigmentation favor the old technique. Further studies with a larger study samples and a longer follow-up period would be desirable with special concern on multiple laser sessions to reach a solid evidence based conclusion regarding which technique is better keeping in mind the effect on repigmentation.

References:-
1. Arnabat-Domínguez, J., M. Bragado-Novel, A. J. España-Tost, L. Berini-Aytés and C. Gay-Escoda (2010). Advantages and esthetic results of erbium, chromium: yttrium–scandium–gallium–garnet laser application in second-stage implant surgery in patients with insufficient gingival attachment: a report of three cases. Lasers in medical science 25(3): 459-464.
2. Atsawasuwan, P., K. Greethong and V. Nimman (2000). Treatment of gingival hyperpigmentation for esthetic purposes by Nd: YAG laser: Report of 4 cases. Journal of periodontology 71(2): 315-321.
3. Azzeh, M. M. (2007). Treatment of gingival hyperpigmentation by erbium-doped: yttrium, aluminum, and garnet laser for esthetic purposes. Journal of periodontology 78(1): 177-184.
4. Basha, M. I., R. V. Hegde, S. Sumanth, S. Sayyed, A. Tiwari and S. Muglikar (2015). Comparison of Nd: YAG laser and surgical stripping for treatment of gingival hyperpigmentation: A clinical trial. Photomedicine and laser surgery 33(8): 424-436.
5. Bergamaschi, O., S. Kon, A. Doine and M. Ruben (1993). Melanin repigmentation after gingivectomy: a 5-year clinical and transmission electron microscopic study in humans. International Journal of Periodontics & Restorative Dentistry 13(1).
6. Berk, G., K. Atici and N. Berk (2005). Treatment of gingival pigmentation with Er, Cr: YSGG laser. J Oral Laser Applications 5(4): 249-253.
7. Bin Cho, S., J. Hee Lee, W. Seo and D. Bang (2010). Use of 532-nm Q-switched Nd: YAG laser for smoker's gingival hyperpigmentation. Journal of Cosmetic and Laser Therapy 12(2): 77-80.
8. Cercadillo-Ibarguren, I., A. España-Tost, J. Arnabat-Domínguez, E. Valmaseda-Castellón, L. Berini-Aytés and C. Gay-Escoda (2010). Histologic evaluation of thermal damage produced on soft tissues by CO2, Er, Cr: YSGG and diode lasers. Medicina oral, patologia oral y cirugia bucal 15(6): e912-918.
9. Chandna, S. and S. D. Kedige (2015). Evaluation of pain on use of electrosurgery and diode lasers in the management of gingival hyperpigmentation: A comparative study. Journal of Indian Society of Periodontology 19(1): 49.
10. Cicék, Y. and U. Ertas (2003). The normal and pathological pigmentation of oral mucous membrane: a review. J Contemp Dent Pract 4(3): 76-86.
11. Cobb, C. M. (2006). Lasers in periodontics: a review of the literature. Journal of periodontology 77(4): 545-564.
12. Coluzzi, D. J. (2004). Fundamentals of dental lasers: science and instruments. Dental Clinics of North America 48(4): 751-770.
13. Convissar, R. A. (2004). The biologic rationale for the use of lasers in dentistry. Dental Clinics of North America 48(4): 771-794.
14. Dummett, C. O. and G. Barens (1967). Pigmentation of the oral tissues: a review of the literature. Journal of periodontology 38(5): 369-378.
15. Eisen, D. (2000). Disorders of pigmentation in the oral cavity. Clinics in dermatology 18(5): 579-587.
16. El Shenawy, H. M., S. A. Nasry, A. A. Zaky and M. A. Quriba (2015). Treatment of Gingival Hyperpigmentation by Diode Laser for Esthetical Purposes. Open access Macedonian journal of medical sciences 3(3): 447.
17. Esen, E., M. C. Haytac, I. A. Öz, Ö. Erdoğan and E. D. Karsli (2004). Gingival melanin pigmentation and its treatment with the CO 2 laser. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology 98(5): 522-527.
18. Giannelli, M., L. Formigl and D. Bani (2014). Comparative evaluation of photoablative efficacy of erbium: yttrium-aluminium-garnet and diode laser for the treatment of gingival hyperpigmentation. A randomized split-mouth clinical trial. Journal of periodontology 85(4): 554-561.
19. Giannelli, M., L. Formigl, M. Lasagni and D. Bani (2013). A new thermographic and fluorescent method for tuning photoablative laser removal of the gingival epithelium in patients with chronic periodontitis and hyperpigmentation. Photomedicine and laser surgery 31(5): 212-218.
20. Grover, H. S., H. Dadlani, A. Bhardwaj, A. Yadav and S. Lal (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): 586.

21. Gurumoorthy Kaarthikeyan, M., N. D. Jayakumar, M. Ogoti Padmalatha, M. Sheeja Varghese and R. Kapoor Pain Assessment Using a Visual Analog Scale in Patients Undergoing Gingival Depigmentation by Scalpel and 970-nm Diode Laser Surgery.

22. Hanada, K., T. Baba, C. Sasaki and I. Hashimoto (1996). Successful treatment of mucosal melanosis of the lip with normal pulsed ruby laser. The Journal of dermatology 23(4): 263-266.

23. Hegde, R., A. Padhye, S. Sumanth, A. S. Jain and N. Thukral (2013). Comparison of surgical stripping; erbium-doped: yttrium, aluminum, and garnet laser; and carbon dioxide laser techniques for gingival depigmentation: a clinical and histologic study. Journal of periodontology 84(6): 738-748.

24. Higgins, J. P., D. G. Altman, P. C. Gotzsche, P. Juni, D. Moher, A. D. Oxman, J. Savovic, K. F. Schulz, L. Weeks and J. A. Sterne (2011). The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 343: d5928.

25. Hujoe, P. P. (2004). Endpoints in periodontal trials: the need for an evidence-based research approach. Periodontology 2000 36(1): 196-204.

26. Karydis, A., P. Bland and J. Shiloah (2011). Management of oral melanin pigmentation. The Journal of the Tennessee Dental Association 92(2): 10-15; quiz 16-17.

27. Kaur, H., S. Jain and R. L. Sharma (2010). Duration of reappearance of gingival melanin pigmentation after surgical removal-A clinical study. The Journal of Indian Society of Periodontology 14(2): 101.

28. Kaya, G. S., G. Y. Yavuz, M. A. Sambil and E. Dayi (2012). A comparison of diode laser and Er:YAG lasers in the treatment of gingival melanin pigmentation. Oral surgery, oral medicine, oral pathology and oral radiology 113(3): 293-299.

29. Kishore, A., R. Kathariya, V. Deshmukh, S. Vaze, N. Khalia and R. Dandgaval (2014). Effectiveness of Er:YAG and CO2 lasers in the management of gingival melanin hyperpigmentation. Oral health and dental management 13(2): 486-491.

30. Ko, H.-J., J.-W. Park, J.-Y. Suh and J.-M. Lee (2010). Esthetic treatment of gingival melanin hyperpigmentation with a Nd: YAG laser and high speed rotary instrument: comparative case report. Journal of periodontal & implant science 40(4): 201-205.

31. Matys, J. and M. Dominiak (2016). Assessment of Pain When Uncovering Implants with Er:YAG Laser or Scalpel for Second Stage Surgery. Advances in clinical and experimental medicine: official organ Wroclaw Medical University 25(6): 1179.

32. Moher, D., A. Liberati, J. Tetzlaff and D. G. Altman (2010). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Int J Surg 8(5): 336-341.

33. Nakamura, Y., M. Hossain, K. Hirayama and K. Matsumoto (1999). A clinical study on the removal of gingival melanin pigmentation with the CO2 laser. Lasers in surgery and medicine 25(2): 140-147.

34. Ozbayrak, S., A. Dumlub and S. Erçalik-Yalcinkaya (2000). Treatment of melanin-pigmented gingiva and oral mucosa by CO2 laser. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology 90(1): 14-15.

35. Ozcelik, O., M. C. Haytac and G. Seydaoglu (2007). Immediate post-operative effects of different periodontal treatment modalities on oral health-related quality of life: a randomized clinical trial. Journal of clinical periodontology 34(9): 788-796.

36. Rathod, D. M. and S. Mulay (2013). Comparative evaluation of ER: YAG and Nd: YAG Laser for gingival depigmentation. Journal of Dental Lasers 7(1): 38.

37. Ribeiro, F. V., C. P. Cavaller, R. C. Casarin, M. Z. Casati, F. R. Cirano, M. Dutra-Corrêa and S. P. Pimentel (2014). Esthetic treatment of gingival hyperpigmentation with Nd: YAG laser or scalpel technique: a 6-month RCT of patient and professional assessment. Lasers in medical science 29(2): 537-544.

38. Romeo, U., F. Libotto, G. Palaia, A. Del Vecchio, G. Tenore, P. Visca, S. Nammour and A. Polimeni (2012). Histological in vitro evaluation of the effects of Er:YAG laser on oral soft tissues. Lasers in medical science 27(4): 749-753.

39. Rosa, D. S. A., A. C. C. Aranha, C. de Paula Eduardo and A. Aoki (2007). Esthetic treatment of gingival melanin hyperpigmentation with Er: YAG laser: short-term clinical observations and patient follow-up. Journal of periodontology 78(10): 2018-2025.

40. Roshna, T. and K. Nandakumar (2005). Anterior esthetic gingival depigmentation and crown lengthening: Report of a case. J Contemp Dent Pract 6(3): 139-147.
41. Sharon, E., B. Azaz and M. Ulmansky (2000). Vaporization of melanin in oral tissues and skin with a carbon dioxide laser: a canine study. Journal of oral and maxillofacial surgery 58(12): 1387-1393.
42. Soliman, M. M., Y. Al Thomali, A. Al Shammarani and H. M. Elgazaerly (2014). The use of soft tissue diode laser in the treatment of oral hyper pigmentation. International journal of health sciences 8(2).
43. Sridharan, S., K. Ganiger, A. Satyanarayana, A. Rahul and S. Shetty (2011). Effect of environmental tobacco smoke from smoker parents on gingival pigmentation in children and young adults: a cross-sectional study. Journal of periodontology 82(7): 956-962.
44. Tal, H., D. Oegiesser and M. Tal (2003). Gingival depigmentation by erbium: YAG laser: Clinical observations and patient responses. Journal of periodontology 74(11): 1660-1667.
45. Thangavelu, A., S. Elavarasu and P. Jayapalan (2012). Pink esthetics in periodontics-Gingival depigmentation: A case series. Journal of Pharmacy And Bioallied Sciences 4(6): 186.
46. Trelles, M., W. Verkruysse, J. Segui and A. Udaeta (1993). Treatment of melanotic spots in the gingiva by argon laser. Journal of oral and maxillofacial surgery 51(7): 759-761.
47. Ünsal, E., C. Paksoy, E. Soykan, A. H. Elhan and M. Şahin (2001). Oral melanin pigmentation related to smoking in a Turkish population. Community dentistry and oral epidemiology 29(4): 272-277.