Case Study

PREVALENCE ASSESSMENT OF GINGIVAL BLACK TRIANGLES FOLLOWING FIXED ORTHODONTIC APPLIANCE TREATMENT AMONG PATIENTS IN SAUDI ARABIA

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ABSTRACT

The gingival black triangle, or open gingival embrasures, a condition caused by the disappearance of interdental papillae, is a crucial aspect of restorative dental care. It affects the gingival's aesthetics and can cause concerns for patients, including appearance, phonetics, food impaction, and oral hygiene maintenance. Current research and data provide very limited answers to the question of the association between orthodontic treatment and gingival black triangles. This sectional study aim to determine the prevalence of gingival black triangles among Saudi Arabian patients who had received fixed orthodontic treatment. The study included 538 participants, 71.9% of whom were females. A significant majority (83.0%) indicated that they had finished their orthodontic treatment. Additionally, 14.1% and 2.2% of individuals reported undergoing treatment for four to six years and more than six years, respectively. The reasons for initiating orthodontic treatment were diverse. The most common reason, cited by 32.5% of respondents, was the presence of gaps between their teeth. The data touched upon the presence of black triangles after orthodontic treatment, with 29.7% of respondents acknowledging their existence, while 70.3% reported not noticing such gaps. A significant portion of respondents (69.4%) discovered the existence of black triangles by themselves, often after brushing or flossing, or by noticing them in the mirror. The prevalence assessment of gingival black triangles following fixed orthodontic appliance treatment among patients in Saudi Arabia revealed that almost one-third of the participants experienced this issue. This indicates a significant occurrence of gingival black triangles in this population.

Key words: Black gingival triangle, Prevalence, Orthodontic, Saudi Arabia.

Introduction

The gingiva's interdental papilla fills the space between two neighboring teeth. This papilla contributes to gingival aesthetics and acts as a biological barrier to protect the periodontal tissues beneath it. When papilla is lost, it can result in cosmetic deformities (sometimes known as "black triangle disease"), phonetic issues where there is room for air or saliva to pass through, and lateral food impaction. A black gingival triangle can result from a missing or short interdental papilla, which is essential to anterior esthetics [1].

Orthodontic therapy in healthy patients is typically linked with brief irritation and a minor injury to the periodontium. A healthy periodontium can also resist tooth movements during orthodontic therapy without the periodontal tissues degrading. Contrarily, orthodontic therapy may also negatively impact periodontal tissues, including root resorption, bone dehiscence, loss of soft tissue architecture, gingival recession, and the development of gingival black triangles (GBT), which could seriously compromise the esthetic result. The interdental papilla is lost when a GBT (also known as an "open gingival embrasure") forms. Additionally, GBT may result in periodontal issues because of food retention and somewhat challenging mechanical plaque control [2].

ITS Any interproximal soft tissue loss brought on by periodontal disease, traumatic mechanical or chemical preparation, or crown lengthening operations is referred to as a "black triangle [3].

There are Black triangles have several potential causes, including stretching of the interdental transseptal gingival fibers during orthodontic therapy. Also contributing to open gingival embrasures may be periodontal response, tooth type, degree of crowding, alveolar bone height, angle generated by the roots of neighboring teeth, and age.

When assessing open gingival embrasures, the majority of earlier research did not take the intricate consequences of

tooth movement into account. According to recent studies, the development of open gingival embrasures may potentially be influenced by the movement of teeth during orthodontic therapy [4].

To accommodate changes in esthetic and functional properties, connections between the soft tissue and underlying bone are changed during orthodontic treatment, moving teeth into new positions [5].

A notable prevalence of gingival black triangles (ranging from 38% to 43.7%) has been documented after orthodontic intervention. This occurrence is incongruent with the contemporary aesthetic expectations of adolescent individuals undergoing orthodontic treatment [6, 7].

A problem of open gingival embrasure arises when the interdental space lacks complete occupancy by gingival tissue, potentially leading to the entrapment of food particles. This phenomenon can negatively impact periodontal health, particularly in adult patients with a history of bone loss [8].

Open gingival embrasures exceeding a measurement of 3 mm were deemed aesthetically less pleasing by both the general population and practitioners in the field of general dentistry [9, 10].

There were no differences between patients' assessments of any black triangle variations before and after orthodontic treatment, according to a 2018 study conducted in Spain [11].

A 2021 study reported that gingival recession and noticeable inflammation were significantly worse at follow-up compared to pre-treatment levels [12].

Another Indian study done in 2022 proves that after receiving orthodontic treatment, 36.42 percent of patients in an average Indian adult orthodontic population have open gingival embrasures [13].

Due to a limited number of people interested in our topic, particularly in Saudi Arabia, previous studies have used a few numbers of samples and produced a wide range of findings. There is conflicting data from the research that links the occurrence of open gingival embrasures (OGEs) to orthodontic treatment. According to some studies, orthodontic treatment causes the development of gingival black triangles, whereas other studies claim that this condition can be prevented by stimulating the growth of interdental papillae. To the best of our knowledge, the published studies and accessible data hardly provide an adequate response to the topic of whether orthodontic treatment and the rising prevalence of gingival black triangles are related. To assess the prevalence of gingival black triangles following treatment with fixed orthodontic appliances among patients in Saudi Arabia.

Materials and Methods

Study design

This study was used of a structured questionnaire developed by the authors as part of an a cross sectional study questionnaire survey, in Saudi Arabia (SA)

Study setting: Participants, recruitment, and sampling

The study's population consisted of Saudi patients who had undergone orthodontic intervention. The study's population comprised Saudi patients classified as adults and aged 18 years or older. The recruitment of participants took place drawing from patients seeking orthodontic treatment across multiple orthodontic clinics situated in various locations within Saudi Arabia.

Sample size

The minimum number of individuals was estimated by using the (Raosoft, Inc., Seattle, WA, USA)(22); means and standard deviation were applied; and the following formula was used: $n = \frac{Z^2 P\,(1-P)}{d^2}$ with standard deviation (=1.96) for a 95% confidence interval and the maximum acceptable marginal error (=0.05).

n: Estimated sample size
Z: The z-value (1-a) = 1.96 for the chosen level of confidence.
P: Expected prevalence
Q: (1-0.50) = 50%, i.e., (0.50)
D: The 0.05 maximum allowable margin of error.

Therefore, the determined minimum individuals was: $n =$ ((1.96)^2 ∗ 0.50 ∗ 0.50)/(0.05)^2 = 384 $participants$.

Inclusion criteria

A minimum of 384 post-treatment patients were selected based on the following criteria: they were at least 18 years old and consented to participate in our study, and they will have completed fixed orthodontic treatment.

Exclusion criteria

Patients who had black triangles before starting fixed orthodontic treatment, patients who did not finish fixed orthodontic treatment, and patients undergoing clear aligner orthodontic or intermaxillary fixation after accidents and fractures were excluded.

Method for data collection and instrument (Data collection technique and tools)

A structured questionnaire was employed as a measurement tool to assess the prevalence of Gingival Black Triangles Following Fixed Orthodontic Appliance Treatment Among Patients in Saudi Arabia. Google Forms were utilized to create the questionnaire and collect data. To assess the

appropriateness, relevance, clarity, and adequacy of the questions, the questionnaire was reviewed by orthodontists. The questionnaire was initially designed in English and subsequently translated into Arabic, the native language of the participants. To gauge the appropriateness, relevance, clarity, and adequacy of the Arabic version, it was evaluated by experts who were native Arabic speakers and volunteers from the general population. Necessary modifications to the Arabic questionnaire were implemented based on the feedback provided by the experts and volunteers. The final version of the questionnaire comprised 19 questions categorized into five main sections.

Scoring system

The first section ensures that the participant sample precisely aligns with the research objective. Participants are asked to specify the type of orthodontic appliance used, either a fixed metal appliance, fixed ceramic appliance, or a clear appliance, and whether they have completed their orthodontic treatment.

The second section includes personal information. The demographic portion of the survey provides valuable insights into the characteristics of the respondents, including gender, age, nationality, and region of residence in Saudi Arabia. Participants are also prompted to clarify if they have any underlying health issues that might affect their condition. This information contributes to a comprehensive understanding of the study's sample population.

The third section encompasses treatment and experience details. In this section, participants are required to provide detailed information about the duration of their orthodontic treatment, and whether they have done orthodontic treatment more than once. Furthermore, they are asked to furnish information regarding their satisfaction level with the appearance of their smile post-treatment and if they notice the presence of black triangles after orthodontic treatment.

The fourth section contains details about the gingival black triangle problem. In this section, inquiries pertain to the presence of family history for gingival black triangle problems, the location, numbers, and resulting issues caused by gingival black triangles, and the discovery method of these triangles.

The fifth section focuses on dental care during and after orthodontic treatment. This section explores the continued use of orthodontic retainers post-treatment, and participants will provide further insights into their dental care habits during and after orthodontic treatment.

Analyzes and entry methods

The computer's "Microsoft Office Excel Software" (2013) program for Windows was used to input data. Then, the data was imported to the SPSS program, version 20 (IBM SPSS Statistics for Windows, Version 20.0; Armonk, NY: IBM Corp.), where it was statistically analyzed.

Results and Discussion

Table 1 showed that in terms of orthodontic type, the majority of respondents had fixed metal braces (81.3%), followed by transparent orthodontic braces (12.8%) and fixed ceramic braces (5.9%). Additionally, a significant majority (83.0%) indicated that they had finished their orthodontic treatment, with only 17.0% reporting that they had not. The distribution of respondents by age shows that the largest group falls within the 20-30 age range (69.0%), followed by the 31-40 age range (11.7%), the less than 20 age range (14.9%), and the 41-50 age range (4.5%). In terms of gender, the data indicates that 71.9% of respondents were female, while 28.1% were male. When it comes to nationality, the vast majority of respondents (95.7%) identified as Saudi, with only a small percentage (4.3%) identifying as non-Saudi. The data also provides insight into the geographic distribution of respondents, with the majority of respondents located in Riyadh (5.9%), Al-Qassim (15.8%), and Eastern regions (8.9%).

Table 1. Sociodemographic characteristics of participants (n=538)

Parameter		No.	%
Orthodontic type	Fixed ceramic braces	44	5.9
	Fixed metal braces	604	81.3
	Transparent calendar	95	12.8
Finished orthodontic treatment	Yes	538	83.0
	no	110	17.0
Age	less than 20	80	14.9
	20_30	371	69.0
	31_40	63	11.7
	41_50	24	4.5
Gender	Male	151	28.1
	Female	387	71.9
Nationality	Saudi	515	95.7
	Non-Saudi	23	4.3
Location	Al-Baha	1	.2
	Hollow	114	21.2
	Northern borders	1	.2
	Riyadh	32	5.9
	Eastern	48	8.9
	Al-Qassim	85	15.8
	AL Madinah AL Munawwarah	54	10.0
	Tabuk	3	.6
	Jazan	6	1.1
	Hail	36	6.7
	difficult	98	18.2
	Makkah	56	10.4

	Najran	4	.7

Table 2 shows the prevalence of health problems among the respondents, with 3.9% indicating that they suffer from such issues. The majority, comprising 96.1%, reported not experiencing health problems. Moving on to the orthodontic treatment period, the data reveals that 16.7% of respondents underwent treatment for less than one year, while a substantial 66.9% had treatment lasting from one to three years. Additionally, 14.1% and 2.2% of individuals reported undergoing treatment for four to six years and more than six years, respectively. The data also includes insights into the recurrence of orthodontic treatment, with 15.6% of respondents reporting having undergone such treatment more than once. The majority, accounting for 84.4%, had not experienced the need for repeated orthodontic intervention. Furthermore, the survey delved into the satisfaction levels regarding the attractiveness of respondents' smiles post-braces. A significant portion, 50.2%, expressed being very satisfied, while 35.1% reported being moderately satisfied. A smaller percentage, ranging from 7.6% to 1.9%, fell into the categories of neutral, moderately dissatisfied, and very dissatisfied. Lastly, the data touched upon the presence of black triangles after orthodontic treatment, with 29.7% of respondents acknowledging their existence, while 70.3% reported not noticing such gaps.

Table 2. Orthodontic treatment of participants (n=538).

Parameter		No.	%
Comorbid diseases	Yes	21	3.9
	no	517	96.1
Orthodontic treatment period	less than one year	90	16.7
	From one to three years	360	66.9
	From four years to six years	76	14.1
	More than six years	12	2.2
Had orthodontic treatment more than once	Yes	84	15.6
	no	454	84.4
Satisfaction with the attractiveness of your smile after braces	Very satisfied	270	50.2
	Moderately satisfied	189	35.1
	Neutral/e	41	7.6
	Moderately dissatisfied	28	5.2
	Very dissatisfied	10	1.9
Noticed the presence of black triangles after orthodontic treatment	Yes	160	29.7
	no	378	70.3

As shown in **Figure 1**, the reasons for initiating orthodontic treatment were diverse. The most common reason, cited by 32.5% of respondents, was the presence of gaps between their teeth. This was followed by problems with advancing or receding teeth (25.1%), crowded teeth leading to the need for extraction (20.6%), and crowded teeth without the need for extraction (15.4%).

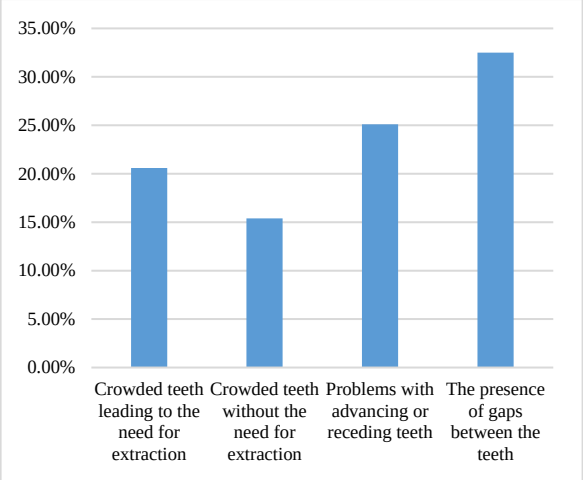

Figure 1. Reason for starting orthodontic treatment among Participants:

Table 3 showed that a significant portion of respondents (69.4%) discovered the existence of black triangles by themselves, often after brushing or flossing, or by noticing them in the mirror. Regarding family history, a notable percentage of respondents (33.1%) reported that neither of their parents or relatives underwent orthodontic treatment. The distribution of black triangles in the mouth after braces varied, with a majority reporting gaps between the front teeth in the upper jaw (66.3%) and the lower jaw (45.0%). The survey also highlighted the frequency of black triangle occurrence, with a majority of respondents (56.9%) reporting the presence of these gaps in two to three places. The problems caused by black triangle gaps were diverse, with food impaction problems (56.3%), appearance issues (52.5%), and lime accumulation problems (45.6%) being the most prevalent. In terms of post-orthodontic retainer usage, a significant portion of respondents reported regular (41.9%) or sometimes regular (38.1%) usage. The survey also shed light on the various methods used for dental hygiene, with the regular toothbrush and paste being the most commonly used (83.1%). Other popular methods included water floss (25.6%), regular dental floss (31.3%), and mouthwash (35.6%).

Table 3. Knowledge of participants of gingival black Triangles following fixed orthodontic appliance (n=160).

Parameter		No.	%
Know about the existence of black triangles by	A doctor told me about it	11	6.9
	By myself, after brushing or flossing, or in the mirror	111	69.4
	I felt it with my tongue	23	14.4
	From a friend or relative	9	5.6
	Other	6	3.8
Parents or relatives undergo regular orthodontic treatment and develop the problem of black triangles between the teeth	Yes	29	18.1
	no	33	20.6
	Neither of them performed orthodontic treatment	53	33.1
	I don't know	45	28.1

Place of black triangles in the mouth that appeared in mouth after braces	Between the front teeth in the lower jaw	72	45.0
	Between the front teeth in the upper jaw	106	66.3
	Between the back teeth in the upper jaw	19	11.9
	Between the back teeth in the lower jaw	12	7.5
Number of black triangles between the teeth can be seen after orthodontic treatment	in one place	48	30.0
	In two to three places	91	56.9
	In four to five places	20	12.5
	Six places and more	1	0.6
Problems caused by the black triangle gaps between the teeth	Food impaction problems	90	56.3
	Lime and lime accumulation problems	73	45.6
	Appearance problems	84	52.5
	Speech problems	9	5.6
	Other	12	7.5
	nothing	14	8.8
Use dental retainer after completing orthodontic treatment	regular	67	41.9
	Sometimes regular	61	38.1
	irregular	32	20.0
Method to clean teeth	Regular toothbrush and paste	133	83.1
	Water floss	41	25.6
	Regular dental floss	50	31.3
	mouth wash	57	35.6
	Water and salt	29	18.1
	toothpick	29	18.1
	toothpick	31	19.4
	Electronic toothbrush and paste	25	15.6
	Other	2	1.3

The prevalence assessment of gingival black triangles following fixed orthodontic appliance treatment among patients in Saudi Arabia is an important topic that sheds light on the potential oral health implications of orthodontic treatment. This cross-sectional study aims to investigate the prevalence of gingival black triangles, which are spaces between the teeth and the gum tissue, in patients who have undergone fixed orthodontic appliance treatment in Saudi Arabia.

Gingival black triangles can be a concern for patients who have undergone orthodontic treatment, as they can affect the aesthetic appearance of the smile and may also pose challenges for oral hygiene maintenance. Therefore, understanding the prevalence of gingival black triangles in this population is crucial for informing treatment planning and patient education [3, 14].

The findings of this study could have implications for orthodontic treatment protocols and patient counseling in Saudi Arabia. If a high prevalence of gingival black triangles is observed, orthodontists may need to consider incorporating strategies to minimize the risk of their development during treatment, fortunately, our study showed a low prevalence rate as only 29.7% of participants noticed the presence of black triangles after orthodontic treatment. Similarly, another study in India showed that out of the entire sample size, 1.73% of individuals had black triangles before orthodontic treatment began, while 98.27% of persons did not. The prevalence of black triangles was assessed in post-treatment pictures and found to be 36.42%, while 63.58% of participants did not exhibit any black triangles [1]. Another systematic study showed that the prevalence of GBT varied between 38% and 58% [2, 4, 15].

Regarding the frequency of black triangles following orthodontic treatment in the Caucasian population, a single publication was found. According to the findings, around 38% of adults undergoing orthodontic treatment have post-treatment open gingival embrasures. The rotation and overlap of the maxillary central incisors before treatment are not directly linked to the occurrence of post-treatment open gingival embrasures [16].

When analyzing the type of malocclusion, it is found that black triangles are most commonly observed in Class I Spacing cases, with an average incidence of 32.95%. This is followed by Class I crowding cases, which have an incidence of 29.48%. Class I Bimaxillary protrusion cases have a lower incidence rate of 23.12%. The elevated incidence of spacing can be linked to the tipping movement employed to close distances in Class I spacing cases [17].

When teeth are positioned on top of each other, the edges at the front will experience uneven wear. Incorrect bracket installation may occur if incisal wear goes unnoticed, as the incisal edge serves as a crucial guide for bracket positioning. This bracket position has the potential to align the incisal edges, but it may also have other effects, resulting in divergent root positioning and gingival embrasure. Before orthodontic treatment, crowded teeth may have severe root tipping. If this tilting is not precisely rectified during the final stages of orthodontic treatment, black triangles can become visible [1].

The management of black triangles can be achieved by both non-surgical and surgical approaches. The non-surgical technique involves correcting oral hygiene procedures, restoring or replacing damaged teeth, and using orthodontic methods. The surgical technique involves many methods such as papilla recontouring, papilla preservation flap, papilla rebuilding using pedicle flap, semilunar coronally moved flap, envelope type flap, autogenous osseous and connective tissue grafts, and microsurgery [18].

Furthermore, the results of this study may contribute to the existing body of literature on orthodontic treatment outcomes and oral health in the Saudi Arabian population. By understanding the prevalence of gingival black triangles and associated risk factors, orthodontic practitioners can tailor their treatment approaches to better meet the needs of their patients and promote optimal oral health outcomes.

The study may have several limitations that should be considered. Some potential limitations could include the sample size and representativeness of the patient population, potential biases in data collection or analysis, and the generalizability of the findings beyond the specific population studied. Additionally, the study may also have limitations related to the methodology used, such as the accuracy of measurements or potential confounding variables that were not accounted for. It's important to critically evaluate these limitations when interpreting the study's results.

Conclusion

In conclusion, the prevalence assessment of gingival black triangles following fixed orthodontic appliance treatment among patients in Saudi Arabia is a valuable area of research that has the potential to inform clinical practice and improve patient care. The prevalence assessment of gingival black triangles following fixed orthodontic appliance treatment among patients in Saudi Arabia revealed that almost one-third of the participants experienced this issue. This indicates a significant occurrence of gingival black triangles in this population.

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References

1. Raksha V, Sri Lakshmi Teja P, Laxmikanth SM, Shrikant S, Chunduri R, Talwar A. Prevalence of Black Triangles in Post Orthodontic Adult Patients - A Retrospective Study. Acta Sci Dent Sci. 2022;6(5):119–24.
2. Rashid ZJ, Gul SS, Shaikh MS, Abdulkareem AA, Zafar MS. Incidence of Gingival Black Triangles following Treatment with Fixed Orthodontic Appliance: A Systematic Review. Healthcare (Basel). 2022;10(8):1373.
3. Seiwert H, Baldrian-Hussein F, Mittag A, Findeisen RD, Sprenger A. Black Triangle- Causes & it's Management. Monum Serica. 1994;42(1):521–60.
4. An SS, Choi YJ, Kim JY, Chung CJ, Kim KH. Risk factors associated with open gingival embrasures after orthodontic treatment. Angle Orthod. 2018;88(3):267-74.
5. Rafiuddin S, Yg PK, Biswas S, Prabhu SS, Bm C, Mp R. Iatrogenic Damage to the Periodontium Caused by Orthodontic Treatment Procedures: An Overview. Open Dent J. 2015;9:228-34.
6. Pugliese F, Hess R, Palomo L. Black triangles: Preventing their occurrence, managing them when prevention is not practical. Semin Orthod. 2019;25(2):175–86.
7. Jeong JS, Lee SY, Chang M. Alterations of papilla dimensions after orthodontic closure of the maxillary midline diastema: a retrospective longitudinal study. J Periodontal Implant Sci. 2016;46(3):197-206.
8. Cunliffe J, Goodwin M, Mahasneh SA, Pretty I. Factors Affecting the Presence or Absence of Interdental Papilla; An in-vivo study. Part II: Influence of Different Parameters on the Presence or Absence of a Black Triangle. Open Dent J. 2022;16(1):1–7.
9. Meeran NA. Iatrogenic possibilities of orthodontic treatment and modalities of prevention. J Orthod Sci. 2013;2(3):73-86.
10. Bolas-Colvee B, Tarazona B, Paredes-Gallardo V, Arias-De Luxan S. Relationship between perception of smile esthetics and orthodontic treatment in Spanish patients. PLoS One. 2018;13(8):e0201102.
11. Bolas-Colvee B, Tarazona B, Paredes-Gallardo V, Arias-De Luxan S. Relationship between perception of smile esthetics and orthodontic treatment in Spanish patients. PLoS One. 2018;13(8):e0201102.
12. Kumar V, Singh P, Arora VK, Kaur S, Sarin S, Singh H. Assessment of Effect of Fixed Orthodontic Treatment on Gingival Health: An Observational Study. J Pharm Bioallied Sci. 2021;13(Suppl 1):S425-8.
13. Kurth JR, Kokich VG. Open gingival embrasures after orthodontic treatment in adults: prevalence and etiology. Am J Orthod Dentofacial Orthop. 2001;120(2):116-23.
14. Genco R, Borgnakke W. Risk Factors For Periodontal Disease Abstract : Learning Objectives : Periodontol 2000. 2014;4(6):59–94. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1600-0757.2012.00457.x
15. Kurth JR, Kokich VG. Open gingival embrasures after orthodontic treatment in adults: prevalence and etiology. Am J Orthod Dentofacial Orthop. 2001;120(2):116-23.
16. Tanaka OM, Furquim BD, Pascotto RC, Ribeiro GL, Bósio JA, Maruo H. The dilemma of the open gingival embrasure between maxillary central incisors. J Contemp Dent Pract. 2008;9(6):92-8.
17. Batra P, Daing A, Azam I, Miglani R, Bhardwaj A. Impact of altered gingival characteristics on smile esthetics: Laypersons' perspectives by Q sort methodology. Am J Orthod Dentofacial Orthop. 2018;154(1):82-90. doi:10.1016/j.ajodo.2017.12.010
18. Singh VP, Uppoor AS, Nayak DG, Shah D. Black triangle dilemma and its management in esthetic dentistry. Dent Res J (Isfahan). 2013;10(3):296-301.