Original Article

A Content Analysis of "Ultra morphology, Surface Roughness of Enamel, and Clinical Manifestations on Dental Health after Various Enamel Stripping, Polishing, and Poststripping Enamel Protection Methods"

ABSTRACT

Background: The purpose of the study is to qualitatively evaluate the ultramorphology, surface roughness, and clinical manifestations on dental health after various stripping, polishing, and postpolishing enamel protection methods which were followed by various researchers to sum up the more pragmatic and less pragmatic results through the research methodology of content analysis.

Objectives: To qualitatively and inductively evaluate various stripping, polishing, and postpolishing enamel protection methods on ultramorphology and enamel surface roughness along with its clinical effects on dental health after thorough content analysis to provide a sound knowledge to the clinician to justify their decisions related to interproximal reduction (IPR), to make it an extremely useful space gaining tool if used with due caution.

Materials and Methods: A comprehensive search of articles related to this study was collected from the past 25 years and a conceptual type of content analysis of all the selected articles was done.

Inferences obtained through the analysis of the documented research data were then summed up in tabular form.

Results: The results summated to the very important fact that all stripping methods microscopically leave a roughened enamel surface but clinically have no deleterious effects on dental health if performed judiciously followed by appropriate polishing and postpolishing protection methods.

Conclusion: It can be determined that IPR should be carried out with greatest caution when using coarser stripping devices followed by prolonged polishing, but cautious use of finer stripping devices could be a better choice along with suitable polishing and protection methods.

Keywords: Content analysis, dental health, enamel stripping, polishing, surface roughness, ultramorphology

INTRODUCTION

Most orthodontic patients before even consulting the orthodontist, enter the clinic with an inbuilt reluctance toward extraction even if it provides the best possible treatment plan, and hence the focus has been shifted toward nonextraction therapy with time.[1] Interproximal enamel reduction as a space gaining method was first described by Ballard in 1944, and it has long

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been preferred in cases chosen for nonextraction treatment approach to gain space for retracting and aligning anterior teeth to resolve mild-to-moderate crowding.[2] Several methods (mechanically driven, manual, and/or chemical) have been used to remove enamel in a controlled and calculated manner keeping in mind the goal of minimizing roughness on the proximal surface postreduction to avoid undesirable hard and soft-tissue effects.[3] Concerns have been raised related to the increase in caries susceptibility, periodontal diseases, iatrogenic damage, and impacts on general dental health post interproximal reduction (IPR) due to the abraded enamel surface and the consequences that follow. The procedure of interproximal stripping needs to be carried out cautiously as it is an invasive technique and leads to irreversible loss of hard tooth structures.[4] A highly useful therapeutic tool, if used judiciously, interproximal stripping is more frequently considered in adult patients with good oral hygiene which itself aids in keeping low susceptibility to caries and in patients with mild-to-moderate crowding with appropriate tooth shape.[5] Interproximal stripping method is technique sensitive where under reduction of enamel would lead to the inability to achieve the desired tooth movement and over reduction would lead to irreparable hard-tissue loss. Under proper precision interproximal stripping has no deleterious effect on the surrounding periodontium (alveolar bone or proximal tissue). Different stripping methods followed by polishing of the stripped enamel surface have been suggested and compared in the past by various researchers to find out either the positive aspects of enamel stripping as a treatment protocol to avoid extraction approach or the deleterious effects on the surface of enamel. On comparison, both more pragmatic and less pragmatic results have been documented in the past available literature over the topic and this article makes an effort to summarize all such findings at one place to compare, discuss, and finally come up with the best possible way to carry out the procedure of enamel stripping by minimizing the possible deleterious effects (if any) of stripping the natural enamel surface for gaining of space. The purpose of the study is to qualitatively evaluate the ultramorphology and surface roughness of permanent tooth enamel and clinical manifestations on dental health of various stripping, polishing, and postpolishing protection methods which were followed by various researchers to sum up the more pragmatic and less pragmatic results through the research methodology of **content analysis**. Content analysis has widely been used in health studies in recent years as a research method. It is a flexible method for analyzing text data.[6] Qualitative analysis of data is useful to deepen understanding of the human experience. Content analysis systematically transforms a large amount of text into highly organized and concise summary of key results.[7]

MATERIALS AND METHODS

1. The method of content analysis as a research tool has been chosen to explore the complex multifactorial phenomenon of the outcomes of various researchers on similar subject in the past 25 years to fill up the lacunae in the available literature and answer all the questions arising through the research articles chosen for this particular study through analysis of the chosen textural data, i.e., the documented research articles
2. A comprehensive search of published and documented articles related to this study was collected from the past 25 years, and these content specific articles were used in the sampling frame
3. A conceptual type of content analysis of all the articles is done as a research methodology, in which the texts are reduced to categories consisting of a word, set of words or phrases which were chosen as "words of identification"
4. The "words of identification" were then categorized in a more pragmatic and less pragmatic coding theme.

Unit of meaning for content analysis

1. The words of identification mentioned in materials and methods for both clinical and microscopic evaluation – their frequency and rate of cooccurrence.
2. Treatment of themes and concepts.

Set of categories for content analysis

As mentioned in materials and methods point 4, the coding will be done in two categories – less pragmatic and more pragmatic.

5. Inferences obtained through the analysis of the documented research data were then summed up in tabular form.

This study was divided into two distinct sections microscopic evaluation and clinical evaluation [Tables 1 and 2].

The "words of identification" for microscopic evaluation are:

- Furrows – visible/disappear, deep/fine or shallow, small in number/more in number
- Roughness
- Morphology
- Smoothness after polishing.

The 'words of identification" for clinical evaluation are:

- Favors plaque adherence
- Decreased resistance to demineralization
- Minor labial gingival recession
- Increased sensitivity
- No difference in caries susceptibility
- No root pathology
- No increased sensitivity to temperature variation

- No iatrogenic damage
- No alveolar bone loss
- No increased incident of periodontal diseases
- Prevents interdental gingival retraction
- No pulp necrosis due to temperature rise of more than 5.5°C above critical level.

Various methods of enamel protection post stripping and/or polishing were mentioned in Table 3.

Content analysis is a research methodology used to analyze documented data either qualitatively or quantitatively in an inductive or deductive way. This study is an inductive content analysis.[14] In inductive content analysis, particular instances are observed and then combined into a larger whole or general statement (Chinn and Kramer 1999).

Qualitative data are organized as the following step and this process includes open coding, creating categories, and

Table 1: Word (s) of identification used throughout search to provide comparative evidence and categorize results of microscopic evaluation into more pragmatic and less pragmatic

Various methods used for inter proximal stripping followed by polishing	More pragmatic	Less pragmatic
16-blade tungsten carbide bur[5]		Furrows visible
8-blade tungsten carbide bur[5]	Finely rough surface	
Coarse diamond bur[5]		Deep furrows
16-blade tungsten carbide bur followed by fine and ultrafine diamond burs for polishing[1,5,8]		Deep furrows
16-blade tungsten carbide bur followed by Sof-Lex disks for polishing[5,8]	Finely rough surface Small number of furrows	Furrows visible
16-blade tungsten carbide bur followed by medium and fine finishing strip with 37% orthophosphoric acid gel on surface for polishing[1]		Alters morphology
Coarse diamond bur followed by fine and ultrafine diamond burs for polishing[1,5]		Deep furrows Alters morphologic features
Diamond disk followed by fine and ultrafine Sof-Lex disks for polishing[1,8,9]	Finely rough surface	Furrows visible
Tungsten carbide bur followed by medium, fine, and ultrafine Sof-Lex disks for polishing[1]	Finely rough surface	Furrows visible
Coarse diamond bur followed by medium, fine, and ultrafine Sof-Lex disks for polishing[1,5]		Deep furrows
8-straight blade tungsten carbide bur followed by fine and ultrafine Sof-Lex disks for polishing1[1,5]	Fine and shallow furrows Furrows disappear	
Diamond coated metal strips followed by Sof-Lex Disk (fine, ultrafine, medium, and coarse) for polishing[2,8]	Smooth surface Small in number Fine and shallow furrows	Furrows visible
Medium grit diamond bur followed by Sof-Lex disk for polishing[2]		Furrows visible
Carbide bur followed by Sof-Lex disk for polishing[2]	Fine and shallow furrows Furrows disappear	
Carbide bur followed by chemical stripping (38% orthophosphoric acid)[2]	Furrows disappear	
Carbide bur followed by chemical stripping followed by sealant application[2]		Rough surface
Profin system[10,11]	Smooth surface with polishing	
Air rotor with standard bur kit[10]		Rough surface Furrows visible
Ortho-strip system[4,10,11]	Smooth with polishing	
Stripping disk[12]	Smooth surface	
Stripping diamond coated metal strips[12]	Smooth surface	
Stripping disk followed by fine Sof-Lex disks for polishing[12]	Smooth with polishing	
Stripping diamond coated metal strips followed by fine Sof-Lex disks for polishing[12]	Smooth with polishing	
Diamond coated metal strip with 37% orthophosphoric acid (chemical stripping)[12]		Alters morphology
Diamond disks followed by diamond burs for polishing[8,9]		Rough Deep furrows Altered morphological features
Diamond disk followed by fine tungsten carbide burs for polishing[9]	Finely rough	
Diamond disk followed by fine finishing strip with 37% orthophosphoric acid gel for polishing[9]		Rough surface
Air rotor stripping with safe tipped bur kit[4,11]		Roughness after polishing
Diamond coated metal strips followed by fine diamond burs for polishing[8]	Fine furrows	

Table 2: Word(s) of identification used through-out search to provide comparative evidence and categorize results of clinical evaluation into more pragmatic and less pragmatic

	Following IPR, polishing, and postpolishing protection methods judiciously	
	More pragmatic clinical effects	**Less pragmatic clinical effects**
Post stripping effects (performed cautiously)	No difference in caries susceptibility No root pathology No increased sensitivity to temperature variation No iatrogenic damage No alveolar bone loss No increased incident of periodontal diseases Prevents inter dental gingival retraction No pulp necrosis due to temperature rise of more than 5.5°C above critical level	Favors adherence of bacterial plaque Decreased resistant to demineralization Minor labial gingival recession Increased sensitivity

IPR: Interproximal reduction

Table 3: Word(s) of identification used throughout search to provide comparative evidence and categorize results of enamel protection poststripping and/or polishing into more pragmatic and less pragmatic

Various methods used for enamel protection post stripping and/or polishing	More pragmatic	Less pragmatic
Sealant without etching[5]		Sealant did not adhere to surface Gaps visible
Sealant with etching[5]	Sealant adhered No gaps seen	
Application of fluoridated gel[2]	More resistant to demineralization	
Fluoride varnish[13]	No demineralization Barrier against demineralization	

abstraction. Notes and headings are written in the text while reading it. The written material is repeatedly read thoroughly, and as many headings as necessary are written down in the margins to describe all aspects of the content (Burnard 1991, 1996, Hsieh and Shannon 2005).

Inclusion criteria

1. Inclusion of only relevant content-specific original research articles (both *in vivo* and *in vitro* studies) on microscopic and clinical effects of enamel stripping methods, polishing, and enamel protection postpolishing in the past 25 years.[1,2,4,5,8-13,15-20]

Exclusion criteria

1. Review articles and case reports on the similar subject were excluded
2. Noncontent-specific articles.

RESULTS

Microscopic evaluation

On detailed analysis of the microscopic evaluation as done by several researches, the comments were paired and compared. The following comments were found and categorized as more pragmatic and less pragmatic [Graph 1].

Less pragmatic

1. Furrows visible – found with seven different methods
2. Furrows deep – found with five different methods
3. Furrows more in number – no finding
4. Rough surface – found with four different methods
5. Alters morphology – found with four different methods
6. Rough after polishing – found with one method.

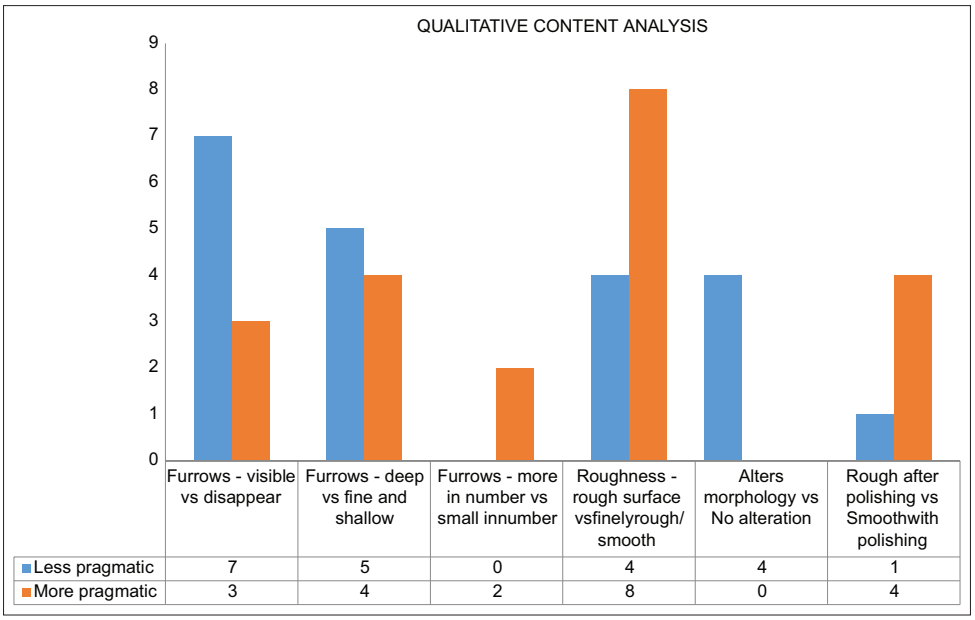
More pragmatic

1. Furrows disappear – found with three different methods
2. Furrows fine and shallow – found with four different methods
3. Furrows small in number – found with two different methods
4. Finely rough or smooth surface – found with eight different methods
5. No alteration in morphology – no finding
6. Smooth after polishing – found with 4 different methods.

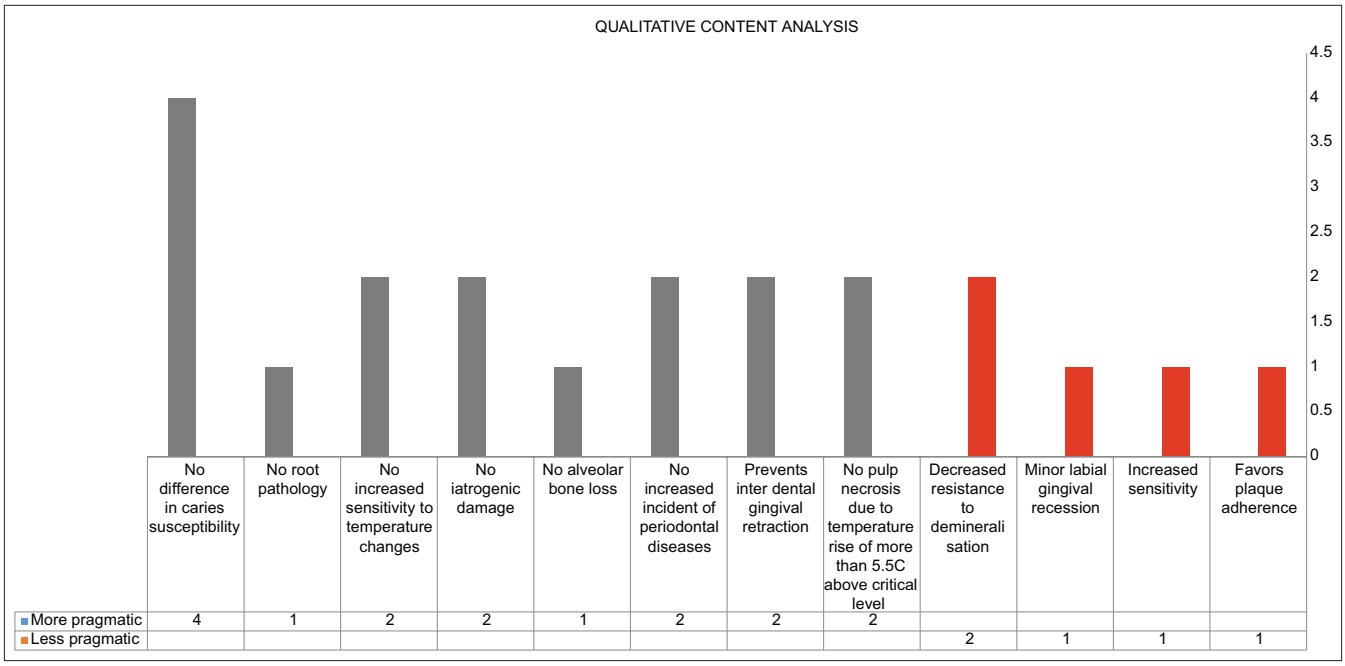
Enamel protection post stripping and/or polishing

On comparison of enamel sealant bond between etched and nonetched stripped enamel surface, it was found that. on etched surface, the sealant adhered and there were no gaps visible, whereas the sealant did not adhere to the surface of nonetched stripped enamel with gaps being visible.[5]

Also that application of fluoridated gel or fluoride varnish increased resistance to demineralization and acted as a barrier against it.[2,13]



Graph 1: A Bar graph showing the outcome of comparative evidence of categorized "words of identification" for the microscopic evaluation[1,2,4,5,8-12]



Graph 2: A Bar graph showing the outcome of comparative evidence of categorized "words of identification" for the clinical evaluation[1,2,10,11,15-19]

Clinical evaluation

On detailed analysis of the clinical evaluation as done by several researches, the findings convey supportive evidence toward the fact that IPR is a clinically safe procedure when performed with precision [Graph 2].

The findings were as follows

Less pragmatic

- Favors plaque adherence[1]
- Decreased resistance to demineralization[2,11]
- Minor labial gingival recession[15]
- Increased sensitivity.[10]

More pragmatic

- No difference in caries susceptibility[2,15,16,17]
- No root pathology[15]
- No increased sensitivity to temperature variation[15,17]
- No iatrogenic damage[15,17]
- No alveolar bone loss[15]
- No increased incident of periodontal diseases[15,17]

- Prevents interdental gingival retraction[15,17]
- No pulp necrosis due to temperature rise of more than 5.5°C above critical level.[18,19]

DISCUSSION

In one of the earliest studies of the decided time period from which the articles were picked for studying, Piacentini and Sfondrini in 1996 compared several stripping methods followed by polishing and came up with a conclusion that best results were found to be with eight straight tungsten carbide bur followed by Sof-Lex disc for polishing as the furrows on the enamel surface after stripping with the bur were finely rough and almost absolutely disappeared after polishing.[1] Kim *et al*. in their study in 2001 found that tooth treated with APF gel or sealant was more resistant to demineralization with better resistant to demineralization seen with the application of APF gel on comparison with sealant. Therefore, they concluded that additional treatment with sealant or calcifying/fluoridating solution is recommended.[2] A 2006 study by Arman *et al*. stated that stripping did not lead to significant change in microhardness of permanent enamel and polishing with Soflex discs decreased surface roughness.[12] Another 2006 study by Jarjoura *et al*. stated that application of topical fluoride immediately after air rotor stripping in patients exposed to fluoridated water and/or toothpaste may not provide additional benefits.[16] The use of coarse strips left irregular surfaces and ended up making the enamel surface rougher as stated in the study by Danesh *et al*. in 2007. He found out that out of the compared methods, O Drive D30 oscillating strips giving the best results.[10] A scanning electron microscopic comparison between various methods by Chirla *et al*. in 2010 used pit and fissure fluoride releasing sealant which was light cured for 20 s with halogen light and came up with the results that sealant did not adhere to the surface when the surface was not etched properly, whereas after etching the stripped enamel surface, the sealant adhered to the surface and no gaps were seen.[5] In a study in 2015 by Hellak *et al*., it was found that air rotor stripping showed highest rate of demineralization as compared to other methods. Also that demineralization increased almost 2.5 times in all groups with or without polishing. No significant difference was found between unpolished and polished samples.[11] SofLex discs were found to be more efficient than fine diamond burs in polishing by Bhambri *et al*. in 2017 with best results found with diamond-coated metal strips, followed by SofLex discs for polishing.[8] Another 2017 study by Vicente *et al*. used profluoride fluoride varnish and stated that it acts as a barrier against demineralization of stripped enamel surface.[13] It was found that mechanical oscillating diamond strips were more efficient when compared to manual stripping and the water rinsing of oscillating system facilitated removal of enamel debris as well in a study by Gazzani *et al*. in 2019.[20] Roughness was reduced for all compared methods except safe tipped bur kit in a study by Danesh *et al*. in 2020 after polishing.[4] In this study, the microscopic evaluation of the studied articles highlighted the fact that it is almost impossible to completely remove the furrows created by the stripping devices on the enamel surface. The difference in depth of the furrows created on the surface was found to be more or less equal with five methods creating deep furrows whereas four methods giving better comparative results of fine and shallow furrows. Two of the methods specifically created a small number of furrows on comparison to other methods, and the enamel surface was found to be finely rough or smooth with only four different methods leaving it rough. Chemical stripping methods altered morphology of the enamel surface, and the surface was found to be smooth after polishing in most of the methods that followed IPR with proper polishing of the enamel surface. The clinical evaluation of the studied articles supported the fact that IPR as a space-gaining method is a safe procedure as the findings highlighted that there is no difference in caries susceptibility and no damage to the proximal tissue and surrounding alveolar bone. There were no reports of iatrogenic damage caused by IPR and no incident of increased temperature sensitivity. Although the sites of enamel reduction favored plaque adherence and decreased resistance to mineralization, application of fluoridated gel/fluoride varnish poststripping and polishing increases the resistance toward demineralization.[2,13]

CONCLUSION

From the above findings, it appears that this study can provide a sound knowledge to the clinician to justify their decisions related to their choice of the method of interproximal stripping, polishing, and postpolishing enamel protection, and under the limitations of this study of a small sample size, it can still be stated that IPR is a highly useful case-specific therapeutic tool if used judiciously. Therefore, it can be assumed that the procedure should be carried out with the greatest caution when using coarser stripping devices in different IPR systems which would demand extended polishing time. Nevertheless, cautious use of the finer stripping devices for IPR could be a better choice along with suitable polishing and protection methods.

This study knocks at further doors of research in the same field for greater validation. Future studies on a larger scale involving more number of global articles would be recommended for better discernment of the subject.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Piacentini C, Sfondrini G. A scanning electron microscopy comparison of enamel polishing methods after air-rotor stripping. Am J Orthod Dentofacial Orthop 1996;109:57-63.
2. Kim KN, Yoon YJ, Kim KW. A study on the enamel surface texture and caries susceptibility in interdentally stripped teeth. Korea J Orthod 2001;31:567-78.
3. Gioka C, Eliades T. Interproximal enamel reduction (stripping): Indications and enamel surface effects. Hel Orthod Rev 2002;5:21-32.
4. Danesh G, Podstawa PKK, Schwartz CE, Kirschneck C, Bizhang M, Arnold WH. Depth of acid penetration and enamel surface roughness associated with different methods of interproximal enamel reduction. PLoS One 2020;15:e0229595.
5. Chirla A, Triveni D, Kumar N, Jayakumar P. A scanning electron microscopic comparison of re-proximated enamel surfaces after various stripping and polishing methods – An *in vitro* study. Journal of Indian Orthodontic Society 2012;44:12-24.
6. Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. Qual Health Res 2005;15:1277-88.
7. Erlingsson C, Brysiewicz P. A hands-on guide to doing content analysis. Afr J Emerg Med 2017;7:93-9.
8. Bhambri E, Kalra JP, Ahuja S, Bhambri G. Evaluation of enamel surfaces following interproximal reduction and polishing with different methods: A scanning electron microscope study. Indian J Dent Sci 2017;9:153-9.
9. Gupta P, Gupta N, Patel N, Gupta R, Sandhu GS, Naik C. Qualitative and quantitative evaluation of enamel after various post-stripping polishing methods: An *in vitro* study. Aust Orthod J 2012;28:240-4.
10. Danesh G, Hellak A, Lippold C, Ziebura T, Schafer E. Enamel surfaces following interproximal reduction with different methods. Angle Orthod 2007;77:1004-10.
11. Hellak AF, Riepe EM, Seubert A, Korbmacher-Steiner HM. Enamel demineralization after different methods of interproximal polishing. Clin Oral Investig 2015;19:1965-72.
12. Arman A, Cehreli SB, Ozel E, Arhun N, Cetinşahin A, Soyman M. Qualitative and quantitative evaluation of enamel after various stripping methods. Am J Orthod Dentofacial Orthop 2006;130: 14.e7-14.
13. Vicente A, Ortiz Ruiz AJ, Gonzalez Paz BM, Garcıa Lopez J, Bravo-Gonzalez LA. Efficacy of fluoride varnishesfor preventing enamel demineralization after interproximal enamel reduction. Qualitative and quantitative evaluation. PLoS One 2017;12:e0176389.
14. Elo S, Kynga SH. The qualitative content analysis process. J Adv Nurs 2008;62:107-15.
15. Zachrisson BU, Nyøygaard L, Mobarak K. Dental health assessed more than 10 years after interproximal enamel reduction of mandibular anterior teeth. Am J Orthod Dentofacial Orthop 2007;131:162-9.
16. Jarjoura K, Gagnon G, Nieberg L. Caries risk after interproximal enamel reduction. Am J Orthod Dentofacial Orthop 2006;130:26-30.
17. Zachrisson B, Minster L, Ogaard B, Birkhed D. Dental health assessed after inter proximal enamel reduction: Caries risk in posterior teeth. Am J Orthod Dentofacial Orthop 2011;139:90-8.
18. Sehgal M, Sharma P, Juneja A, Kumar P, Verma A, Chauhan V. Effect of different stripping techniques on pulpal temperature: *In vitro* study. Dental Press J Orthod 2019;24:39-43.
19. Banga K, Arora N, Kannan S, Singh AK, Malhotra A. Evaluation of temperature rise in the pulp during various IPR techniques – An *in vivo* study. Prog Orthod 2020;21:40.
20. Gazzani F, Lione R, Pavoni C, Mampieri G, Cozza P. Comparison of the abrasive properties of two different systems for interproximal enamel reduction: Oscillating versus manual strips. BMC Oral Health 2019;19:247.