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Study of Separation Efficacy and Pain with Various Commonly Used Orthodontic Separators

Honey Jivrani[1], Yazad Daruwala[2], Pallav Udeshi[2]
[1]*Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Goenka Dental College, Gandhinagar.*
[2]*Private Practice*

Abstract
Background*: Normally, adjacent teeth maintain a tight interproximal contact with each other. Therefore, their separation is required to allow for the placement of orthodontic bands. Different types of separators like brass wires, latex elastics, elastomeric and spring-type steel separators have been used in orthodontics.*
Materials and Methods*: This study is conducted to check the amount of separation achieved in maxillary and mandibular permanent first molars on application of three different types of separators i.e., Elastomeric separators, custom-made Kesling separators made of 0.018" Australian wire with double helix and 0.020" Australian wire with single helix. In 45 patients Kesling separators made of 0.018", 0.020" Australian wire and elastomeric separators were inserted on right and left sides respectively. Separation was checked and compared after 48 hours of insertion and pain perception was checked using visual analogue scale at 1 hour, 24 hours and 48 hours of insertion in young adult subjects.*
Results*: Significantly more separation occurred at sites where elastic separators were used compared to 0.018" Kesling separator with double helix and 0.020" Kesling separator with single helix. Between 0.018" and 0.020" Kesling types, more amount of separation occurred at the site where 0.018" Kesling separators were used.*
Conclusion: *Separation caused by elastic separators was maximum while that of 0.020" Kesling separator with single helix caused minimum separation in both maxillary arch as well as in mandibular arch.*
Key Words*: Orthodontic Separation, Kesling Separators, Elastomeric separators.*

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I. Introduction

For treatment with a fixed orthodontic appliance, separation of the molars is necessary to create enough space for the bands that anchor the appliance. The most economical and commonly used wire separator, which was made of a 0.016" SS Australian wire and conformed to actual biological needs of the periodontium was a spring separator introduced by Kesling[1] in 1957.

Different types of separators have been used in orthodontics (e.g., brass wires, latex elastics, and elastomeric and spring-type steel separators). They vary in the amount of pain they cause during separation, their effectiveness in separating teeth and maintenance of the separation gained.

Normally, adjacent teeth maintain tight interproximal contact point relationships with each other. Therefore, their separation is required to allow for the placement of bands. Moreover, the contact point of posterior teeth is almost 3 times tighter than that of anterior teeth[2,3], so that excessive force is required to place molar bands. Adequate separation reduces physical pain to the lowest possible degree, prevents injury to the tooth structure from excess pressure and prevents injury of the soft tissue. It also prevents distortion of the band material by not having to forcibly position it during band placement[9].

This study was carried out with the following aims and objectives:

1. To measure the amount of separation achieved with three types of separators i.e., elastomeric separators, 0.018" Kesling separator with double helix and 0.020" Kesling separator with single helix at the end of 48 hours of insertion.
2. Comparative evaluation of the pain/discomfort perceived by the patients (male and female) with each of separator at various time interval after its insertion. (1hr, 24hrs and 48 hrs)
3. To select the separator that gives optimum separation in the prescribed time interval.

II. Material And Methods

This study was carried out evaluate and compare the efficacy of different types of orthodontic separators and pain perceived by the patient at different time intervals.

Inclusion criteria:

1. Cases without history of previous orthodontic treatment.
2. Presence of all permanent teeth in both arches except third molars.
3. Proximal contacts should be present between adjacent molars.
4. Absence of proximal restoration in permanent 2nd premolar, 1st and 2nd molars.

Exclusion criteria:

1. Presence of dental caries and endodontic treatment in posterior teeth.
2. Presence of periodontal and mucogingival problems, systemic disorders, TMJ disorders, habit of bruxism or attrition.
3. Previous history of trauma and orthodontic treatment.
4. If subject has taken pain relief medication.

Types of Separators Used:

1. **Elastomeric separator**
   This polyurethane separator by ORTHO ORGANISERS® (radiopaque- blue regular) is grasped in separator placing pliers, stretched and placed interdentally. It is fitted snugly in the interdental region.

2. **0.018" Kesling separator with double helices**
   Kesling separator made up of 0.018" AJ Wilcock SS wire (special +), comprises of two coils/helices, occlusal arm and gingival arm. It was grasped with plier and then placed in such a way that coil remains on the buccal side.

3. **0.020" Kesling separator with single helix**
   Kesling separator made up of 0.020" AJ Wilcock SS wire (special +), comprises of single coil/helix, occlusal arm and gingival arm. It was grasped with plier and then placed in such a way that coil remains on the buccal side.

4. **Feeler gauge**
   The feeler gauge consists of 25 straight metal blades ranging from a thickness of 0.04mm to 1 mm (Fig 1). The amount of separation was measured using the blades.

5. **Visual Analogue Scale (VAS)**
   The Visual Analogue Scale (VAS) is a 10 cm line with anchor statements on the left (no pain) and on the right (extreme pain) (Fig 1). The patient is asked to mark their current pain level on the line. They were also asked to mark their maximum, minimum, and average pain. The examiner notes the VAS score by measuring the distance in centimeters (0 -10) from the "no pain" anchor point.

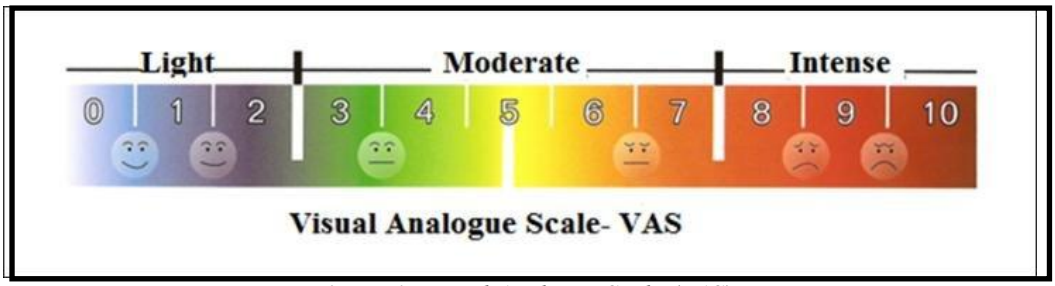

Figure 1- *Visual Analogue Scale (VAS)*

Methodology

- A total of **45 subjects** (22 males and 23 females) with an age group ranging from 14 to 30 years were taken for this study. Oral prophylaxis of all the subjects was done before the placement of separators.
- The subjects were divided into three groups i.e., **Group A, Group B, and Group C** based on the types of separators used with only one type of separator being used on each side of the arch.
- Subjects were advised not to take pain relief medication until the follow up appointment.

- Subjects were asked to rate the pain/discomfort on Visual Analogue Scale after 1 hour, 24 hours and 48 hours of separator insertion. Separators were removed after 48 hours. After air drying the interdental spaces amount of separation was measured on each side of the permanent 1st molars using feeler gauge.
- **Group A** consisted of first 15 patients, elastomeric separators were inserted on the right side (1st and 4th quadrant) and 0.018" Kesling separators with double helix were inserted on the left side (2nd and 3rd quadrant) (Fig 2).

Figure 2- *Elastomeric separators in 1st and 4th quadrant and 0.018" Kesling separators with double helix in 2nd and 3rd quadrant*

- **Group B** consisted of next 15 patients, elastomeric separators were inserted on the right side (1st and 4th quadrant) and 0.020" Kesling separators with single helix were inserted on the left side (2nd and 3rd quadrant) (Fig 3).

Figure 3- *Elastomeric separators in 1st and 4th quadrant and 0.020" Kesling separators with single helix in 2nd and 3rd quadrant*

- **Group C** consisted of last 15 patients, 0.018" Kesling separators with double helix were inserted on the right side (1st and 4th quadrant) and 0.020" Kesling separators with single helix were inserted on the left side (2nd and 3rd quadrant) (Fig 4).

Fig 4- *0.018" Kesling separators with double helix in 1st and 4th quadrant separators in 1st and 4th quadrant and 0.020" Kesling separators with single helix in 2nd and 3rd quadrant*

- In all the three groups, separation on mesial and distal aspect of first permanent molars of each quadrant were measured with feeler gauge (Fig 5).

Figure 5- *Amount of separation measured at each side of permanent 1st molars*

- Pain threshold/level of discomfort was assessed by Visual Analogue Scale (VAS) on right and left sides at three different time intervals i.e., 1 hour, 24 hours and 48 hours after insertion of separators (Fig 1).
- Patient was asked to score the severity of pain or discomfort felt on the scale of 0 to 10 (0 being no pain and 10 being highest pain) after insertion of different types of separators at different time interval on both right and left sides individually.
- After collecting the required data, needful statistical analyses were carried out to determine the results.

Statistical analysis:

- Mean and standard deviation values were calculated for the separation achieved by the three types of separators at 48 hrs of insertion.
- To compare the mean separation achieved by Elastic vs 0.018" (Group A), Elastic vs 0.020" (Group B), and 0.018" vs 0.020" (Group C), the ANOVA Test was performed. (p value < 0.05)
- Level of pain threshold was compared amongst the male and female subjects on right and left sides at different time intervals i.e., after 1 hr, 24 hrs and 48 hrs, caused by different type of separators using repeated measures ANOVA test.
- The correlation between the amount of separation and pain perception for three different types of separators was calculated using Pearson correlation test.

III. Results

		MEAN	SD	p value	INFERENCE
ELASTIC V/S 0.018" (Group A)	**ELASTIC**	0.27	0.06	0.000	HIGHLY SIGNIFICANT
	0.018"	0.17	0.05		
		MEAN	**SD**	**p value**	**INFERENCE**
ELASTIC V/S 0.020" (Group B)	**ELASTIC**	0.27	0.06	0.000	HIGHLY SIGNIFICANT
	0.020"	0.13	0.02		
		MEAN	**SD**	**p value**	**INFERENCE**
0.018" V/S 0.020" (Group C)	**0.018"**	0.17	0.05	0.000	HIGHLY SIGNIFICANT
	0.020"	0.13	0.02		

Table 1- *Assessment of level of differences in the amount of separation achieved (mm)* ***after 48 hrs*** *between the different types of separators used in* ***maxillary arch***

Table 1 shows the level of difference in the amount of separation achieved in maxillary arch on comparing different types of separators with each other on their application for 48 hours respectively. Significantly more separation occurred at sites where elastic separators were used compared to 0.018" Kesling separator with double helix and 0.020" Kesling separator with single helix. However, between 0.018" and 0.020" Kesling types, more amount of separation occurred at the site where 0.018" Kesling separators were used. This suggests that the efficacy of 0.018" Kesling separator is more due to double helix design as compared to 0.020" Kesling separators with single helix.

Table 2 shows the level of difference in the amount of separation achieved in mandibular arch on comparing different types of separators with each other on their application for 48 hours respectively. Significantly more separation occurred at sites where elastic separators were used as compared to 0.018" Kesling and 0.020" Kesling separators. However, between 0.018" Kesling and 0.020" Kesling separators, more amount of separation occurred at the site where 0.018" Kesling separators were used.

		MEAN	SD	p value	INFERENCE
ELASTIC V/S 0.018"	**ELASTIC**	0.25	0.05	0.000	HIGHLY SIGNIFICANT
	0.018"	0.16	0.04		
		MEAN	**SD**	**p value**	**INFERENCE**
ELASTIC V/S 0.020"	**ELASTIC**	0.25	0.05	0.000	HIGHLY SIGNIFICANT
	0.020"	0.16	0.02		
		MEAN	**SD**	**p value**	**INFERENCE**
0.018" V/S 0.020"	**0.018"**	0.16	0.04	0.000	HIGHLY SIGNIFICANT
	0.020"	0.13	0.02		

Table 2- *Assessment of level of differences in the amount of separation achieved (mm)* ***after 48 hrs*** *between the different types of separators used in* ***mandibular arch***

FEMALES									
	Elastic			**0.018"**			**0.020"**		
	1 HR	**24 HRs**	**48 HRs**	**1 HR**	**24 HRs**	**48 HRs**	**1 HR**	**24 HRs**	**48 HRs**
MEAN	3.29	5.53	5.47	1.88	3.56	3.31	1.54	3.62	3.08
SD	1.49	1.28	1.94	1.31	1.21	1.20	0.66	1.04	0.95
MALES									
	Elastic			**0.018"**			**0.020"**		
	1 HR	**24 HRs**	**48 HRs**	**1 HR**	**24 HRs**	**48 HRs**	**1 HR**	**24 HRs**	**48 HRs**
MEAN	2.85	5.69	4.69	1.57	3.50	2.71	2.06	3.65	3.18
SD	1.82	2.18	1.89	1.09	0.94	0.73	1.03	0.93	0.95

Table-3 *shows mean and SD values of VAS score recorded in female and male subjects for three types of separators used for time intervals 1 hr, 24 hrs and 48 hrs.*

1 HR TIME INTERVAL							
FEMALES				MALES			
SEPARATOR TYPE	Mean	SD	p value	SEPERATOR TYPE	Mean	SD	p value
ELASTIC	3.29	1.49	**0.007**	ELASTIC	2.85	1.82	**0.041**
0.018"	1.88	1.31		0.018"	1.57	1.09	
ELASTIC	3.29	1.49	**0.000**	ELASTIC	2.85	1.82	0.179
0.020"	1.54	0.66		0.020"	2.06	1.03	
0.018"	1.88	1.31	0.379	0.018"	1.57	1.09	0.214
0.020"	1.54	0.66		0.020"	2.06	1.03	
24 HR TIME INTERVAL							
FEMALES				MALES			
SEPARATOR TYPE	Mean	SD	p value	SEPERATOR TYPE	Mean	SD	p value
ELASTIC	5.53	1.28	**0.000**	ELASTIC	5.69	2.18	**0.004**
0.018"	3.56	1.21		0.018"	3.50	0.94	
ELASTIC	5.53	1.28	**0.000**	ELASTIC	5.69	2.18	**0.006**
0.020"	3.62	1.04		0.020"	3.65	0.93	
0.018"	3.56	1.21	0.900	0.018"	3.50	0.94	0.667
0.020"	3.62	1.04		0.020"	3.65	0.93	
48 HR TIME INTERVAL							
FEMALES				MALES			
SEPARATOR TYPE	Mean	SD	p value	SEPERATOR TYPE	Mean	SD	p value
ELASTIC	5.47	1.94	**0.001**	ELASTIC	4.69	1.89	**0.003**
0.018"	3.31	1.20		0.018"	2.71	0.73	
ELASTIC	5.47	1.94	**0.000**	ELASTIC	4.69	1.89	**0.018**
0.020"	3.08	0.95		0.020"	3.18	0.95	
0.018"	3.31	1.20	0.560	0.018"	2.71	0.73	0.136
0.020"	3.08	0.95		0.020"	3.18	0.95	

Table-4 *Estimating level of difference found in males and females when two different types of separators used for same duration of time interval.*

Table-4 shows level of difference found in pain and discomfort felt when two different types of separators were placed for similar duration of time in males and females.

- For 1 hr time interval, there is a statistically significant difference in the amount of pain/discomfort when two different types of separators are compared with each other. In females, more amount of pain is felt with elastomeric separators as compared to 0.018" Kesling separators, however there is no statistically significant difference in amount of pain when 0.018" Kesling and 0.020" Kesling separators are compared. While in males, more amount of pain is felt when elastic separators are used as compared to 0.018" Kesling separators. However, there is no statistically significant difference in amount of pain when elastic and 0.020" Kesling separators are compared.
- For 24 hrs time interval, in both males and females, more amount of pain is felt when elastic separators are used, as compared to both 0.018" Kesling and 0.020" Kesling separators. The difference is statistically significant. However, there is no difference in the amount of pain felt when 0.018" Kesling and 0.020" Kesling separators are compared.
- For 48 hrs time interval, for both in males and females, more amount of pain is felt when elastic separators are used, as compared to both, 0.018" and 0.020" Kesling separators. The difference is statistically significant. however, there is no difference in the amount of pain felt when 0.018" and 0.020" Kesling separators are compared.

IV. Discussion

Separation of contact points between adjacent teeth is an integral part of conventional orthodontic treatment protocol as well as certain dental procedures. An ideal separator should quickly and comfortably create space for proper band adaptation and stay secure between appointments.

Different amount of separation is observed clinically for various types of separators. The present study was conducted to check the efficacy of three different types of separators when inserted for 48 hours and to check the effective separation achieved with the same. A total of 45 young adult subjects (22 males and 23 females) were divided into 3 groups based on the type of separators used on mesial and distal sides of permanent 1st molars in all four quadrants. Mean and standard deviation of the amount of separation and VAS score were calculated for all the groups and needful statistical analysis was carried out to compare the efficacy of three different types of separators as well as pain felt with the same at different time intervals.

In the present study, mean separation for maxillary and mandibular first molar at 48 HRs of insertion for three types of separators were calculated and compared which showed that the maximum amount of separation was achieved with elastomeric separators (0.27 mm), followed by 0.018" Kesling separators with double helix (0.17 mm), while minimum separation was achieved with 0.020" Kesling separators with single helix (0.13 mm). Similar results were obtained by **Bondmark et al[4]**, maximum separation was achieved with the elastomeric separators (0.4 mm) and minimum separation was achieved with spring type separators (0.3 mm).

There are numerous methods of measuring and assessing pain[14,15]. The main benefit of the VAS is that the scores appear to have the qualities of ratio data and may be treated as such statistically, providing that the data are normally distributed. Visual Analogue Scale was used in the present study to assess the pain/discomfort intensity, because it is one of the most commonly used tools to measure pain/discomfort intensity and is easy to both administer and score. Mean values were calculated at three different time intervals i.e., after 1 hr, 24 hrs and 48 hrs of separator insertion. For all the three types of separators, the results showed significant difference in pain and discomfort felt with increase in wear time (from 1 hr to 24 hrs and 24 hrs to 48 hrs) of a particular type of separator in males and females. In this study the patients had no problem in discriminating the pain or discomfort in right and left side when two different types of separators were placed and compared respectively.

In this study, when two different types of separators were compared for similar duration of time in males and females, the results showed that elastomeric separator causes highest pain/discomfort as compared to 0.018" and 0.020" Kesling separators. This suggests that Kesling separators are less painful as compared to elastomeric separators. Similar to this study, **Hoffman et al[5]** compared different separators and concluded that the latex separators gave the most pain, followed by the spring separators. **Gurinder Pal Singh Sandhu et al[6]** reported that the most comfortable separators on chewing, biting, fitting your back teeth together were the Kesling separators as compared to elastomeric separators. Similar to the present study, **Bondmark et al[4]** concluded that the springs were considered less painful than the elastomeric separators. However, in contrast to present study **Achint Juneja et al[7]** concluded that, no difference was found in the intensity of pain on VRS (Verbal Rating Scale) between elastomeric separators and spring separators on all three days.

In the current study for elastomeric separators, pain gradually increased from 1 hr to 24 hrs for both males and females, and remained same till 48 hrs. For 0.018" Kesling separators with double helix and 0.020" Kesling separators with single helix, pain gradually increased from 1 hr to 24 hrs and gradually decreased till 48 hrs for both males and females. Similarly, **Bergius et al[8]** using elastic separators, reported that the intensity of pain reached the highest level the day after placement of separators and gradually reduced after 1 week.

V. Conclusion

The findings of the present study while assessing effectiveness of three commonly used different types of separators when placed on either side of maxillary and mandibular permanent first molars along with level of pain and discomfort felt by young adult male and female subjects suggest that:

1. Amount of separation observed at 48 hrs differ significantly when any two types of separators are compared with one another. Separation caused by elastic separators was maximum while that 0.020" Kesling separator with single helix caused minimum separation in both maxillary arch as well as in mandibular arch.

2. Level of pain and discomfort increases from insertion of any type of separator to 24 hrs which subsequently decreases from 24 hrs to 48 hrs in males and females both.

3. When level of pain and discomfort is compared between two different time intervals for any particular type of separator, males and females show significantly rise in level of pain and discomfort from time interval 1 hr to 24 hrs which subsequently reduces significantly from 24 hrs to 48 hrs for any type of separators.

4. When level of pain and discomfort is compared between two different types of separators at similar time interval, it is observed that males and females having elastic separators show significantly higher level of

pain and discomfort at all time intervals in comparison to those with 0.018" and 0.020" Kesling types of separators. However, no difference is found between 0.018" and 0.020" types of separators.

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