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# Comparison of Cephalometric and Dental Cast Measurements of Patients Treated with Single Lower Incisor Extraction and Non-extraction Orthodontic Treatment

# Alt Tek Keser Çekimli ve Çekimsiz Ortodontik Tedavi Uygulanan Hastaların Sefalometrik ve Model ölçümlerinin Karşılaştırılması

## ABSTRACT

### Objective:
The aim of this retrospective study was to compare the treatment results of patients treated with non-extraction (NE) and single lower incisor extraction (SLIE) using cephalometric and dental cast analysis.

### Materials and Methods:
The lateral cephalometric radiographs and dental casts of 40 patients (20 patients of treated with Single Lower Incisor Extraction (SLIE), and 20 patients of treated with non-extraction (NE) were examined. The positions of the upper and lower incisors were examined cephalometrically; dental arch widths, arch lengths, Little Irregularity Index and Bolton Analysis were measured on the dental casts.

### Results:
In the SLIE and NE group, the amounts of maxillary irregularity were 2.67 ± 0.30 (mm) and 3.07 ± 0.36 (mm), the amounts of mandibular irregularity were 7.11 ± 0.27 (mm) and 3.29 ± 0.46 (mm) respectively. Lower intercanine (3-3) width was significantly decreased in the SLIE group and the changes between the groups were statistically significant as well. In SLIE group, no statistically significant change was observed in the parameters of the upper and lower incisor measurements, while in the NE group, the upper incisor angle (1-NA˚) and the distance of the upper incisors to the N-A plane (1-NA (mm)) increased significantly ($P < 0.05$).

### Conclusion:
Successful dentoalveolar outcomes may be achieved by performing SLIE therapy as an alternative to NE applied to treat Class I patients with mandibular irregularity. Lower incisor extraction can be applied to avoid lower incisor protrusion.

### Key Words:
Non-extraction orthodontic treatment, Single lower incisor extraction, Bolton's analysis.

## ÖZ

### Amaç:

Bu retrospektif çalışmanın amacı alt tek keser çekimli ve çekimsiz ortodontik tedavi uygulanan hastaların tedavi sonuçlarını sefalometrik ve model analizleriyle karşılaştırmaktır.

### Gereç ve Yöntemler:

Çalışmamızda 40 hastanın (alt tek keser çekimli 20 hasta ve çekimsiz tedavi edilen 20 hasta) lateral sefalometrik radyografları ve dental modelleri incelenmiştir. Alt ve üst keser konumları sefalometrik olarak; dental ark genişlikleri, ark uzunlukları, Little irregularite indeksi ve Bolton analizi dental modeller üzerinde değerlendirilmiştir.

### Bulgular:

Alt tek keser çekimli ve çekimsiz tedavi gruplarında sırasıyla maksiller çapraşıklık miktarı
2.67 ± 0.30 (mm) ile 3.07 ± 0.36 (mm), mandibular çapraşıklık miktarı ise 7.11 ± 0.27 (mm) ile 3.29 ± 0.46 (mm)'dir. Model analizinde alt kaninler arası (3-3) genişlik alt tek keser çekimli grupta istatistiksel olarak anlamlı miktarda azalmıştır ve gruplar arasındaki değişimler anlamlı bulunmuştur ($P < 0.05$). Alt tek keser çekimli grupta sefalometrik olarak alt ve üst keser pozisyonlarındaki değişimlerde istatistiksel olarak anlamlı bir değişiklik gözlenmezken çekimsiz grupta üst keser açısı (1-NA˚) ve üst keserin N-A düzlemine olan uzaklığı [1-NA (mm)] istatistiksel olarak anlamlı miktarda artmıştır ($P < 0.05$).

### Sonuç:

Mandibular çapraşıklığa sahip Sınıf I hastaların tedavisinde kullanılan çekimsiz tedaviye alternatif olabilecek alt tek keser çekimli ortodontik tedaviyle başarılı dentoalveoler sonuçlar elde edilebilir. Keser protrüzyonunu önlemek için tek keser çekimi uygulanabilir.



### Anahtar Sözcükler:

Çekimsiz ortodontik Tedavi, Tek alt keser çekimi, Bolton analizi.


## INTRODUCTION

Lower anterior dental crowding that causes aesthetically unpleasant dental appearance has been one of the common orthodontic problems (1-5). There are many fixed orthodontic treatment approaches for solving the lower incisor crowding such as non-extraction (NE) treatment by protruding the incisors, treatment with interproximal stripping, premolar extraction and one or two lower incisors extraction treatment. Tooth extraction orthodontic treatment has been a controversial issue for a long time (6,7). Extraction of premolar is usually preferred to treat crowding. However, extraction of these teeth is limited because of concerns about negatively affected facial profile due to the retracted incisors and lips. On the other hand, incisors protrusion without extraction is another method for solving the crowding, which was abstained in patients with thin alveolus or the one who tends to have periodontal diseases (6). Mesiodistal stripping provides only 3-4 mm space gain in the anterior alveolus, which may not be enough to solve the crowding. Single lower incisor extraction (SLIE) treatment has been reported by many clinicians and was found to be more effective than other options in some selected cases by achieving stable results in the anterior region (inter-canine (3-3) width is not increased) (8), and also for avoiding unpleasant retrusive facial profile (9-11). According to Kokich and Shapiro (1) SLIE in some cases can be useful to achieve the development of aesthetics and occlusion with minimal orthodontic treatm ent. However, this treatment is not very common compared to premolar extraction treatment because few patients are suitable for the standards for such treatments (12).

SLIE was first introduced in 1942 by Hahn to treat crowding (13). This is not an eligible approach for the symmetrical treatment of malocclusions, but in some clinical situations, SLIE treatment may be a treatment option that can be obtained acceptable occlusion according to the needs of the patient (6,14-23). Moreover, this treatment can be utilized to keep the arch form and width without expansion of the 3-3 width (24). Riedel et al. (8) stated that one or two lower incisor extraction treatment is the only reasonable treatment to provide stable anterior region in patients with lower crowding teeth. Furthermore, it was stated that SLIE can be performed in patients with Bolton discrepancy (irregularity between upper and lower teeth widths) (14,22). Some other factors to be assessed for this treatment in the literature have been reported as lower incisor crowding, tooth size irregularity, pathological conditions, overbite, overjet, sagittal incisor relationship, skeletal growth pattern, age of the patient, increased widths of lower incisors and narrow upper incisors (11,14,25-27).
Kamal et al. (28) found similar PAR scores in comparison of NE, premolar extraction, and SLIE treatments in patients with Class I anterior crowding. However, Ileri et al. (3) reported that NE treatment resulted in more desirable outcomes than premolar extraction and SLIE regarding the occlusion in Class I patients with moderate to severe mandibular anterior crowding. In another study (29) it was reported that the SLIE or NE treatment were caused similar changes in occlusal characteristics (overjet, overbite and 3-3 width). There is a controversy among clinicians about this technique and its effects on the occlusion and arch forms. Therefore, in the present study, it was aimed to examine the changes in the arch dimensions and cephalometric upper-lower incisor relationships of patients treated with NE and SLIE treatment retrospectively.

## MATERIALS and METHODS

This study was conducted on the materials of patients treated with SLIE and NE orthodontic treatment. For this purpose, lateral cephalometric radiographs and dental casts of 20 patients treated with SLIE in the Orthodontics Department of Süleyman Demirel University Hospital (2011-2015) were examined. For the control group, another 20 patients treated with NE treatment were retrieved from the archieve. Inclu-

sion criteria of this study were:
- No functional orthopedic treatment before fixed therapy,
- No congenital tooth agenesis or loss of teeth for any reason,
- No congenital anomaly in the craniofacial region,
- No systemic disorder,
- The cases were completed in an acceptable occlusion.

Measurements of the changes in the alveolar arch on the dental casts obtained at pre-treatment and post-treatment were performed with the digital caliper. Maxillo-mandibular changes, projection of upper and lower incisors were evaluated with the lateral cephalometric radiographs which were obtained beginning and at the end of the treatment. Cephalometric and dental cast parameters used in this study are defined below:

## Dental Cast Measurements:

**1. The anterior lower tooth-size Bolton excess:**
The mesiodistal widths of six upper incisor teeth, from the right canine to the left canine are totaled and compared with the sum derived by the same procedure carried out on the lower six incisor teeth. The ratio between both measurements is the percentage relationship of lower anterior arch length to the upper anterior arch length and compared with the mean values in the Bolton ratio analysis and the excess of anterior tooth size were evaluated (30).

**2. The over all lower tooth-size Bolton excess:**
The mesiodistal widths of twelve upper teeth, from the right first permanent molar to the left first permanent molar are totaled and compared with the sum derived by the same procedure carried out on the lower twelve teeth. The ratio between both measurements is the percentage relationship of over all lower arch length to the over all upper arch length and compared with the mean values in the Bolton tooth ratio analysis and the excess of tooth size were evaluated (30).

**3. Little Irregularity Index:**
The summed displacement of the anatomic contact points of the lower anterior teeth (31).

**4. The amount of maxillary irregularity:**
It is the amount of irregularity between maxillary teeth.

**5. The amount of mandibular irregularity:**
It is the amount of irregularity between maxillary teeth.

**6. Upper 3-3 width:**
The upper right and upper left canines are the distance between the cusp tip of the tooth (Fig. 1.a.1).

**7. Lower 3-3 width:**
The lower right and lower left canines are the distance between the cusp tip of the tooth
(Fig.1.b.1).

**8. Upper inter-1st premolar (4-4) width:**
The distance between the buccal cusp tips of the upper right and upper left 1st premolar teeth (Fig. 1.a.2).

**9. Lower 4-4 width:**
The distance between the buccal cusp tips of the lower right and lower left 1st premolar teeth (Fig. 1.b.2).

**10. Upper inter-2nd premolar (5-5) width:**
The distance between the buccal cusp tips of the upper right and upper left 2nd premolar teeth (Fig. 1.a.3).

**11. Lower 5-5 width:**
The distance between the buccal cusp tips of the lower right and lower left 2nd premolar teeth (Fig. 1.b.3).

**12. Upper inter-1st molar (6-6) width:**
The distance between the bucco-mesial cusp tips of the upper right and upper left 1st molar teeth (Fig. 1.a.4).

**13. Lower 6-6 width:**
The distance between the bucco-mesial cusp tips of the lower right and lower left 1st molar teeth (Fig. 1.b.4).

**14. Upper arch length:**
Upper arch length is the sum of the distance between the mesial contact of the right upper molar tooth, and the distance between the contact point of the two central incisors, and the mesial contact of the left upper molar tooth and the distance between the central incisors (Fig. 1.c).

**15. Lower arch length:**
Lower arch length is the sum of the distance between the mesial contact of the right lower molar tooth and the distance between the contact point of the two central incisors and the mesial contact of the left lower molar tooth and the distance between the central incisors (Fig. 1.d).

**16. Overjet:**
Overjet is the distance horizontally from the labial surface of the lower incisor to the incisal edge of the upper incisor.

**17. Overbite:**
Overbite is the distance vertically from the incisal edge of the upper incisor to the incisal edge of the lower incisor.

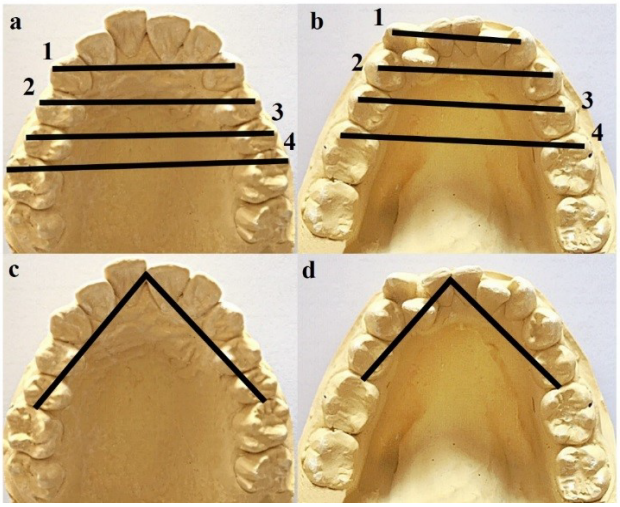


**Figure 1.** Dental cast measurements.

**Cephalometric Measurements:**

1. SNA˚: It is the angle between the Sella, Nasion and A points.
2. SNB˚: It is the angle between the Sella, Nasion, and B points.
3. ANB˚: It is the angle between the A, Nasion and B points.
4. SND˚: It is the angle between the Sella, Nasion and D points.
5. Pog-NB (mm): It is the distance between Pogonion and the plane passing through the point of N and B.
6. Interincisal Angle: It is the angle between axis of the upper central incisor and the axis of lower central incisor.
7. GoGn-SN˚: It is the angle formed between GoGn and SN planes.
8. Upper lip-S (mm): Perpendicular distance from the upper lip point to S line.
9. Lower lip-S (mm): Perpendicular distance from the lower lip point to S line.
10. IMPA˚: It is the angle formed between Go-Me and axis of the lower incisor.
11. Witt's (mm): It is the distance between the projection of A and B points on the occlusal plane.
12. 1-NA (mm): It is the distance between the incisor edge of the upper central incisor and the plane passing through the point of N and A.
13. 1-NA˚: It is the angle between the axis of upper central incisor and the plane passing through the point of N and A.
14. 1-NB (mm): It is the perpendicular distance between the incisor edge of the lower central incisor and the plane passing through the point of N and B.
15. 1-NB˚: It is the angle between the axis of lower central incisor and the plane passing through the point of N and B.

For the statistical analysis, SPSS 22.0 (Statistical Package for Social Science for Windows, version 22.0, SPSS Inc., Chicago, Illinois, USA) was used. The paired sample t-test was used evaluation of the intra-group changes with the treatment. The independent group t-test was used to determine the differences of treatment variables in SLIE and NE treatment groups, depending on the normal distribution. The level of statistical significance was accepted as $P < 0.05$.

## RESULTS

The average ages of SLIE group and NE group were 16.09 ± 3.91 years and 15.10 ± 3.90 years, respectively (Tab. 1). The groups were similar in terms of age. In both groups, the gender distribution was not statistically different.

**Table 1.** Age and gender distributions.

| | | SLIE | NE | Total |
|---|---|---|---|---|
| **Number of patients** | | 20 | 20 | 40 |
| **Age (year)** | | 16.09 ± 3.91 | 15.10 ± 3.90 | |
| **Gender** | Female | 11 | 14 | 25 |
| | Male | 9 | 6 | 15 |

The comparisons of the dental cast measurements obtained at the start of the treatment are shown in Table 2. The anterior lower tooth-size Bolton excess, the over all lower tooth-size Bolton excess, Little Irregularity Index and the amount of Mandibular Irregularity were found different significantly between groups ($P < 0.05$).

**Table 2.** Dental cast measurements comparisons between the groups.

| Parameters | SLIE | NE | p |
|---|---|---|---|
| **The anterior lower tooth-size Bolton excess** | 2.36 ± 0.16<br>Min: 1.3 - Max: 3.7 | 0.69 ± 0.19<br>Min: 0.4 - Max: 2.6 | * |
| **The over all lower tooth-size Bolton excess** | 3.08 ± 0.25<br>Min: 1.8 - Max: 4.9 | 0.31 ± 0.56<br>Min: 0.8 - Max: 1.8 | * |
| **Little irregularity index** | 9.18 ± 0.90<br>Min: 2.0 - Max: 15.9 | 5.00 ± 0.68<br>Min: 1.0 - Max: 10.3 | * |
| **The amount of maxillary irregularity** | 2.67 ± 0.30<br>Min: 1.0 - Max: 6.0 | 3.07 ± 0.36<br>Min: 1.0 - Max: 5.0 | NS |
| **The amount of mandibular irregularity** | 7.11 ± 0.27<br>Min: 5.5 - Max: 9.0 | 3.29 ± 0.46<br>Min: 1.0 - Max: 6.0 | * |

*p: Independent group t test significance value; NS: non significant; *:p<0.05.*

Upper dental cast analysis showed that there were statistically increase the 3-3 width and 4-4 and 5-5 widths, and were no changes in 6-6 width and arch length in the SLIE group (Tab. 3). However, there was no change in 3-3 width, and was a statistically significant increase in upper arch length in the NE Group. These findings were found to be similar except 3-3 width in both groups.

When the lower dental cast analysis was evaluated, it was found that there was a statistically significant decrease in lower 3-3 width, increase in lower 5-5 width and lower 6-6 width in the SLIE group ($P < 0.05$), and was no change in lower arch length ($P < 0.05$). Moreover, lower 4-4 width and lower arch length were increased, and there were no changes in lower 6-6 width in NE Group. Lower 3-3 width and lower 5-5 width were revealed to be diffirent in both group. On the other hand, the increase of lower arch length was found higher in the NE group. There was no significant difference in overjet and overbite in both groups and minimal changes were similar between groups. (Tab. 3)

**Table 3.** Pre-treatment (T0) and post-treatment (T1) changes in dental cast measurements and comparisons between groups.

| | SLIE Group | | | NE Group | | | Difference |
|---|---|---|---|---|---|---|---|
| **Dental Cast Measurements** | **T0** $\bar{X} \pm S\bar{x}$ | **T1** $\bar{X} \pm S\bar{x}$ | **T1-T0 p** | **T0** $\bar{X} \pm S\bar{x}$ | **T1** $\bar{X} \pm S\bar{x}$ | **T1-T0 p** | **p** |
| **Upper 3-3 width** | 33.27 ± 0.79 | 34.93 ± 0.34 | * | 36.11 ± 0.44 | 35.69 ± 0.34 | NS | # |
| **Lower 3-3 width** | 25.19 ± 0.32 | 22.95 ± 0.22 | * | 27.29 ± 0.44 | 27.36 ± 0.28 | NS | # |
| **Upper 4-4 width** | 40.36 ± 0.55 | 42.85 ± 0.66 | * | 42.19 ± 0.48 | 43.91 ± 0.35 | * | NS |
| **Lower 4-4 width** | 32.98 ± 0.62 | 33.64 ± 0.60 | NS | 34.39 ± 0.36 | 35.82 ± 0.33 | * | NS |
| **Upper 5-5 width** | 45.82 ± 0.52 | 47.88 ± 0.61 | * | 47.80 ± 0.52 | 49.20 ± 0.42 | * | NS |
| **Lower 5-5 width** | 37.91 ± 0.45 | 40.91 ± 0.57 | * | 40.18 ± 0.52 | 41.73 ± 0.39 | * | # |
| **Upper 6-6 width** | 51.70 ± 0.63 | 51.98 ± 0.59 | NS | 52.86 ± 0.58 | 52.84 ± 0.51 | NS | NS |
| **Lower 6-6 width** | 43.66 ± 0.70 | 44.34 ± 0.63 | * | 44.99 ± 0.51 | 45.10 ± 0.55 | NS | NS |
| **Upper arch length** | 69.08 ± 0.78 | 70.08 ± 0.73 | NS | 70.57 ± 0.79 | 73.31 ± 0.73 | * | NS |
| **Lower arch length** | 57.49 ± 0.68 | 58.38 ± 0.61 | NS | 60.44 ± 0.73 | 63.16 ± 0.64 | * | ## |
| **Overjet** | 4.70 ± 0.55 | 4.86 ± 0.33 | NS | 3.20 ± 0.29 | 3.05 ± 0.16 | NS | NS |
| **Overbite** | 2.84 ± 0.37 | 2.20 ± 0.16 | NS | 1.80 ± 0.40 | 1.55 ± 0.19 | NS | NS |

*$\bar{X}$, mean value; $S\bar{x}$, standard error;#; SLIE difference > NE difference; ##: NE difference > SLIE difference; NS: non significant; *:p<0.05 $\bar{X}$, mean value; $S\bar{x}$, standard error; #: SMIE difference > NE difference;##:; SMIE difference > NE difference; NS: non significant; *:p<0.05.*

When cephalometric parameters were analysed, there was no statistically significant changes in sagittal skeletal parameters (SNA˚, SNB˚, ANB˚, SND˚ and Witts) following the treament neither in SLIE nor in NE groups. Upper and lower lips projections did not show significant changes either. There was a statistically significant decrease in interincisal angle in NE Group. Positions of upper and lower incisors were not significantly changed in the SLIE Group. However, there was a statistically significant increase in the 1-NA (mm) and 1-NA˚ in the NE Group, and the increases were found to be statistically significant between the groups. (Tab. 4).

**Table 4.** Pre-treatment (T0) and post-treatment (T1) cephalometric changes and comparisons between groups.

| | SLIE Group | | | NE Group | | | Difference |
|---|---|---|---|---|---|---|---|
| Cephalometric Measurements | T0 $\bar{X}\pm s\bar{x}$ | T1 $\bar{X}\pm s\bar{x}$ | T1-T0 p | T0 $\bar{X}\pm s\bar{x}$ | T1 $\bar{X}\pm s\bar{x}$ | T1-T0 p | p |
| SNA(˚) | 79.93 ± 0.50 | 79.98 ± 0.46 | NS | 79.66 ± 0.58 | 79.43 ± 0.65 | NS | NS |
| SNB(˚) | 78.98 ± 0.55 | 78.77 ± 0.59 | NS | 78.45 ± 0.55 | 78.42 ± 0.55 | NS | NS |
| ANB(˚) | 0.95 ± 0.28 | 1.22 ± 0.32 | NS | 1.21 ± 0.30 | 1.01 ± 0.39 | NS | NS |
| SND(˚) | 75.22 ± 0.59 | 75.30 ± 0.69 | NS | 75.35 ± 0.75 | 75.66 ± 0.77 | NS | NS |
| Pog-NB (mm) | 1.27 ± 0.60 | 1.84 ± 0.26 | NS | 1.46 ± 0.59 | 0.86 ± 0.31 | NS | NS |
| Interincisal Angle (˚) | 121.81 ± 1.38 | 121.29 ± 1.45 | NS | 124.88 ± 2.30 | 123.34 ± 2.50 | * | NS |
| GoGn-SN(˚) | 31.02 ± 1.34 | 30.53 ± 1.56 | NS | 33.96 ± 1.21 | 33.20 ± 1.36 | NS | NS |
| Upper lip -S (mm) | -0.95 ± 0.44 | -0.55 ± 0.56 | NS | -1.61 ± 0.49 | -1.30 ± 0.40 | NS | NS |
| Lower lip -S (mm) | -0.31 ± 0.54 | -0.65 ± 0.69 | NS | -0.40 ± 0.47 | -0.27 ± 0.39 | NS | NS |
| IMPA(˚) | 94.82 ± 1.49 | 94.57 ± 1.57 | NS | 95.52 ± 1.15 | 95.70 ± 1.01 | NS | NS |
| Witt's (mm) | -0.01 ± 0.45 | -0,46 ± 0.59 | NS | -1.23 ± 0.43 | -1.44 ± 0.34 | NS | NS |
| 1-NA (mm) | 4.54 ± 0.50 | 5.25 ± 0.49 | NS | 3.48 ± 0.60 | 6.31 ± 0.60 | * | ## |
| 1-NA˚ | 22.82 ± 1.35 | 25.73 ± 1.01 | NS | 21.16 ±1.68 | 26.55 ± 1.43 | * | ## |
| 1-NB (mm) | 3.75 ± 0.54 | 3.41 ± 0.44 | NS | 5.05 ± 0.48 | 5.79 ± 0.52 | NS | NS |
| 1-NB˚ | 22.53 ± 1.97 | 23.55 ± 1.56 | NS | 27.76 ±1.25 | 28.89 ± 1.23 | NS | NS |

*$\bar{X}$, mean value; $s\bar{x}$, standard error; ##; NE difference>SLIE difference; NS: non significant; *:p<0.05*

## DISCUSSION

Main goals of the orthodontists are to achieve better function, occlusal and aesthetic results with an appropriate treatment method in a short period of time, and also provide long-term stability. It is very important to determine the best treatment plan with case specific approaches regarding the esthetics, function and stability (24,32,33).

Lower incisor crowding is one of the common problems of orthodontic anomalies (34) while lower incisor extraction is not common for the correction of this irregularity (22,35). Common concerns about SLIE may not be providing ideal occlusion with Class III molar relationship and also causing midline discrepancy. On the other hand, maintaining the presence arch form without increasing 3-3 width would allow the clinicians to achieve stable results. Some authors suggested that SLIE treatment can be used for patients characterized by the presence of extremely irregularity or protruded incisors, which requires to decrease dental volume so as to achieve proper alignment and leveling with normal inclinications of the incisors in the alveolus (8,9,14).

The lower tooth size excess more than 1.6 mm as noted by Bolton's analysis is considered significant, which requires dental reduction such as stripping to provide a good occlusion (22,30). SLIE is usually performed in patients with Bolton discrepancies greater than 2.0 mm. In different studies, the range of the tooth size discrepancy has been reported between 1.3-4.6 mm for SLIE treatment (22,36-38). In the present study, similar to the previous ones, patients in SLIE had more than 2mm tooth size discrepancy in favor of lower teeth. Maintaining the lower arch form and avoiding the expansion of 3-3 width during orthodontic treatment after permanent canine eruption are not suggested since the stability is not provided (8,39). It has been reported that the lower 3-3 width was decreased or did not change in patients treated with lower incisor extraction (8,14,22,39). In the present study, decreases in lower 3-3 widths were statistically significant in the SLIE group, and this difference was found statistically significant between groups. One of the limitations of this study was to have short term results. Long term results need to be evaluated with larger samples in further studies.

Changes in 4-4 and 6-6 widths were measured in this study as well. There was no statistically significant change in lower 4-4 width in the SLIE Group, while a significant increase in 5-5 width was found in this group even though second premolars were far from the extraction site. This change can be negligible clinically since it was limited by approximately 0,7 mm. In the literature, it was stated that orthodontic treatment with extraction caused a decrease in 6-6 width in the major of the cases (8,35,40). Riedel et al. (8) found that the lower 6-6 width was increased with lower incisor extraction, and this change was similar to that of NE treatment group. In an article regarding with a lower incisor extraction treatment, there was an increase in lower 6-6 width as well (22). Similar to previous studies an increase (approximately 0,7 mm) in lower 6-6 width was observed in this study.

Riedel et al. (8) reported that lower arch length was decreased significantly following the treatment with two lower incisor extraction, but there was no change in SLIE group. In the present study, there was no statistically significant change in the lower arch length in SLIE Group similar to their study, while there was a significant increase in the NE Group. This increase probably resulted from the incisor protrusion in the NE group.

Changes in interocclusal relationships of the anterior teeth can be expected following SLIE. This change may include increases in overjet and overbite depending on the pretreatment occlusal characteristics of the patients as reported by some authors, because all dimensions of the lower arch are reduced (33,39,41), and the other lower incisors can be aligned by extrusion and retraction (36,37,42). There is another study in which reported significant decreases in overjet and overbite as well (8). In the present study, there was no significant change in neither overjet nor overbite in accordance with one of the previous studies (35). This maintenance of the anterior relationship indicated that the space of

the incisor extraction was only used for crowding. These mechanics are closely related to the pretreatment amount of crowding and anchorage type. Thus, incisor positions can be maintained with proper indications of SLIE, in turn, maintaining the soft tissue profile and lip projections can be achieved, which is one of the advantages of lower incisor extraction (11,43,44).

Different amounts of changes in the upper and lower incisor positions following SLIE were reported in previous studies and case reports. These changes were reported as protrusion of both incisors (22), retrusion of upper incisors (17,22), retrusion of lower incisors (22) and no change in the inclination of them (35,44). Positions of upper and lower incisors did not show significant changes following SLIE treatment in the present study. Thus, the lip projection was also maintained and unpleasant effects of retruded incisors on the lips were avoided. However, a midline discrepancy should be expected after the SLIE treatment, which may have a negative effect on smiling in some patients. Especially in adult cases with lower incisor appearance during speaking and smiling, midline discrepancy would be more notable after SLIE treatment. Therefore clinicians should do functional examination of the patients before making a decision about the extraction and patients should be informed about midline discrepancies, and tooth extraction should be performed after patient consent is obtained.

## CONCLUSION

The results of this study indicated that patients treated with SLIE showed more Bolton discrepancy than patients treated with NE. Furthermore, incisors' inclinations were not changed statistically in SLIE group while increased in NE group. The difference in change of 3-3 width after the treatment was remarkable between the groups. Bolton analyses should be used for each case before the treatment and SLIE may be preferred in cases with Bolton discrepancy for avoiding a dilemma which lets the clinician make a decision between causing retrusive lips and facial profile or extremely protracted lower incisors. It is necessary to evaluate the advantages and disadvantages of the SLIE treatment for each case.

**Ethics Committee Approval:**
The study was approved by Suleyman Demirel University Faculty of Medicine Clinical Research Ethics Committee (Approval number: 72867572-050-2222 and date: July 21, 2015)

**Author contribution statement:**
Concept, Design, Materials, Data Collection and/or Processing, Analysis and/or Interpretation, Literature Search, Writing Manuscript and Critical Review – E.E., E.Y.C.

**Conflict of Interest:**
The authors declare that they have no conflict of interest.

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