



## A CLINICAL STUDY OF ORTHODONTIC SPACE CLOSURE BY 4 DIFFERENT TECHNIQUES

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**Abstract: Objectives:** This study is designed to evaluate the orthodontic rate of space closure after first premolar extraction between canine and 1<sup>st</sup> molar. It comprises of four different techniques of closure of space by power E chain, active tieback, NiTi closed coil spring and mini screw attached with E chain. **Materials and Methods:** In this study there were 20 sample patient which is distributed uniformly in 4 groups, 5 for E chain, 5 for active tieback, 5 for NiTi closed coil spring and 5 for mini screw attached to E chain. After the levelling and alignment 0.019x 0.025 ss wire placed for one month then maxillary and mandibular study model were collected at start of space closure (T0) and four month later (T1). Space present in all four quadrant was measured, and calibrated by examiner using vernier callipers at T0 and T1 The rate of space closure, in millimetre per month and 4 monthly rates, was then calculated. Kodon 9 mm NiTi spring having 200 gm forces is used to retract canine. Sk surgical 1.5 x 9 mm screw is used to retract the canine. Mini implant was placed in the buccal interradicular space between the second premolar and the first molar in maxillary andmandibular arches. The data was entered into the excel sheet. The data was

analysed using SPSS (Statistical Package for Social Sciences) 20.0 version. The data was analysed for probability distribution using Kolmogorov-Smirnov test. The intra-group comparison was done using paired 't' test. The inter-group comparison was done using One-way ANOVA followed by post hoc analysis. **Results:** The study included 20 sample specimens belonging to 4 groups based on the type of space closure method used. Group 1- NiTi closed coil spring, Group 2- Active tie back, Group 3- Power E chain, Group 4- Mini screw with E chain. Post hoc analysis revealed that the rate of space closure in group 1 was significantly more than that in group 2. rate of space closure was non-significantly different between group 1 and group 3, group 1 and group 4, group 2 and group 3 and between group 3 and group 4 ( $p \text{ value} > 0.05$ ). **Conclusion:** Our study has shown that NiTi springs delivering 200gm forces gave the most rapid rate of space closure and may be considered the treatment of choice. Mini screw with polyurethane powerchain is best for anchorage and its rate of space closure is non-significant with polyurethane power chain but its rate of space closure is less than NiTi closed coil spring. But at the same time, it is expensive and require surgical exposure to the patient.

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**Introduction:** In this study, we set out to evaluate the effectiveness of four space closure methods: polyurethane power E chain, active ligatures, and nickel titanium (NiTi) springs and mini screw attached with polyurethane power E chain for orthodontic closure of space. During orthodontic treatment including extraction of teeth, there is often a requirement to close remaining space. When sliding mechanics are used with the straight wire appliance for space -closure, 100–200 g of force has been suggested with the help of elastic or wire springs.<sup>1</sup>

For space closure, there are several commonly used methods of applying this force: that is elastic modules<sup>2</sup>, elastic chain and NiTi springs. Though, the potential shortcoming of elastic chain or active modules is the noteworthy force decay over time<sup>3-6</sup>. As a consequence; NiTi springs are a substitute in widespread use. NiTi springs have the described advantage of giving suggestively quicker and more consistent rates of space closure<sup>2, 7, 8</sup>, but then expensive to use. Comparing with NITI, active ligatures are cheap and perhaps easier for the patient to keep clean. Translation or rotation of the tooth caused by simple force upon which it acts, nearer the line of action of force to the tooth's centre of resistance, possibility of translation is more relative to rotation & vice versa<sup>9</sup>.

Movement of tooth through bone depends upon a biologic response whose mechanics is apparently sensitive to differential in pressure and tension within PDL ligament, electric potential deformation or bending of bone, & which is time dependant<sup>10</sup>

If a heavy force were employed, without its moment arm on anterior teeth were kept very small, it might produce extreme strain at the alveolar crest and apex<sup>11,12</sup> Edgewise force levels were initially used to close spaces; however, it was soon observed that lighter forces were more effective with sliding mechanics<sup>16</sup>. If module was prestretched or worked before use. If used direct from manufacturer, without pre-stretching, the force may be 200-300 gm greater<sup>17</sup>. It has been reported that different clinicians have successfully used different types of modules, with different pre-stretching & different amount of stretching when placed in the mouth<sup>18</sup>

In 1997, Kanomi published a case report on the use of mini-implants for orthodontic anchorage. These devices held promise as a low-cost anchorage technique that would be well tolerated by patients, would be clinically and anatomically flexible, and could be loaded immediately. In our study mini screw is used both for anchorage and to compare rate of space closure with conventional technique.

In our study polyurethane powerchain was attached with mini screw was used both for anchorage and to compare rate of space closure with conventional technique.

### **Aims & Objectives**

1. This study is designed to evaluate the orthodontic rate of space closure after first premolar extraction between canine and 1<sup>st</sup> molar. It comprises of four different techniques of closure by power E chain, active tieback NiTi closed coil spring and mini screw attached with E chain.
2. To compare the rate of space closure between right and left segment of maxillary and mandibular arch.

### **Materials Used:**

1. Kodon elastic module.
2. Kodon 9mm NiTi closed coil spring.
3. Digital Vernier calliper.
4. Posted archwire.
5. 0.019 x 0.025 SS wire.
6. Kodon 0.010-inch SS ligature wire.

7. Kodon MBT metallic bracket Kit.
8. Mathieu Forceps.
9. Elastic chick retractor.
10. Kodon polyurethane power chain.
11. Kalabhai Orthokal.
12. Preformed Posted orthodontic band.
13. Alginate impression materials.
14. BK surgical 1.5 X 9 mm mini screw.
15. BK Surgical mini screw driver.
16. Dentaurum Plastic model base former.
17. Impression tray.
18. Bracket Placing Tweezer.
19. Kodon Composite & Primer
20. Rubber Separators.
21. Rubber Separators Plier
22. Distal end Cutter.
23. Ligature Wire Cutter.
24. Led light cure.

**Methods:** The present study was undertaken at department of orthodontics and dentofacial orthopaedics, at Awadh Dental College and Hospital, Jamshedpur. In this study there were 20 sample taken patient which is distributed uniformly in 4 groups, 5 for E chain, 5 for active tieback, 5 for NiTi closed coil spring and 5 for mini screw attached to power e chain. The data was entered into the excel sheet. The data was analysed using SPSS (Statistical Package for Social Sciences) 20.0 version. The data was analysed for probability distribution using Kolmogorov-Smirnov test, p value greater than 0.05 indicated that the data was normally distributed. The intra-group comparison was done using paired 't' test. The inter-group comparison was done using One-way ANOVA followed by post hoc analysis. P value <0.05 was considered statistically significant. Confidence interval was set at 95%.

**Inclusion Criteria:**

1. Patient undergoing fixed orthodontic treatment having class I bi-maxillary protrusion with all 4 first pm extraction.
2. 12-20 year of age.
3. After levelling and aligning had completed.

4. Informed consent was taken from sample patient.

All the patients were treated with MBT technique (0.022 × 0.028-in. slot). An order of aligning wires was used for leveling and alignment until a 0.019 × 0.025-in. stainless steel arch wire could be passively engaged.

Digital Vernier calliper were used to measure the maximum distance between the cusp tip of canine to the buccal cusp tip of first permanent molar at all quadrant at the interval between T0 and T1.

Maxillary and Mandibular study model were collected at start of space closure (T0) & four month later (T1). Space present in all four quadrant was measured, and calibrated by examiner using vernier callipers at T0 & T1. The rate of space closure, in millimetre per month & 4 monthly rates, was then calculated.

Active ligatures were constructed from one grey elastic module & long ligature. Type 1 active ligature is used initial force was constant i.e., 200gm of force applied by all four groups and measured by dontrix gauge. Active ligature is replaced at each visit. Continuous power chain was placed from the first molar hook on posted archwire. Having a constant force, changed at subsequent visit.

Koden 9mm NiTi spring having 200 gm forces is used to retract canine. 150 gm force is equally effective (maharastburger)<sup>40</sup>.

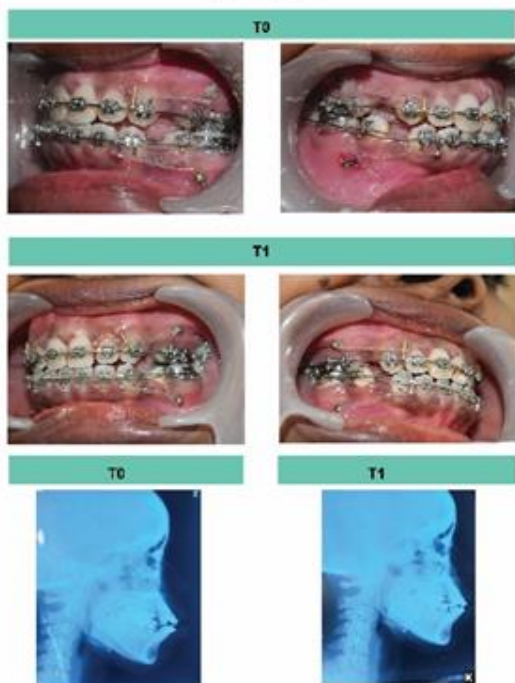
Sk surgical 1.5 x 9 mm screw is used to retract the canine. Mini implant placement in the buccal interradicular space between the second premolar and the first molar in maxillary and mandibular arches Polyurethane power chain is attached from posted archwire hook that is placed between lateral and canine to mini screw.

The study was lawful by the Institutional Ethics Committee and consent was obtained from all the patients, Guardians of the patients.

The data was entered into the excel sheet. The data was analysed using SPSS (Statistical Package for Social Sciences) 20.0 version. The data was analysed for probability distribution using Kolmogorov-Smirnov test, p value greater than 0.05 indicated that the data was normally distributed. The intra-group comparison was done using paired 't' test. The inter-group comparison was done using One-way ANOVA followed by post hoc analysis. P value <0.05 was considered statistically significant. Confidence interval was set at 95%.

**FIG- 1**

Photograph & X-ray at T0 (Starting of retraction ) and T1 (After 4 months of retraction ) by polyurethane power chain attached with mini screw.



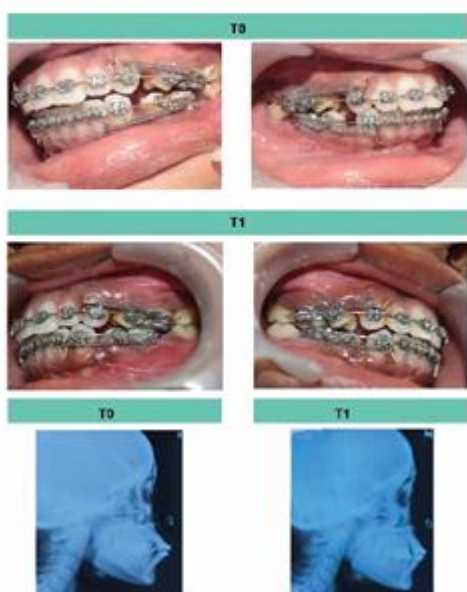
**FIG- 2**

Photograph & X-ray at T0 (Starting of retraction ) and T1 (After 4 months of retraction ) with polyurethane power chain



**FIG- 3**

Photograph & X-ray at T0 (Starting of retraction ) and T1 (After 4 months of retraction ) with closed coil spring.



**FIG-4**

Photograph & x-ray at T0 (Starting of retraction ) and T1 (After 4 months of retraction ) with Active Tie back.

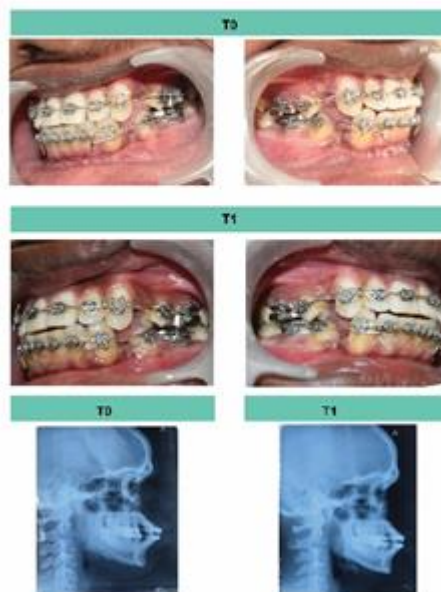


FIG-5

Cast analysis at T0 (Starting of retraction ) and T1 (After 4 months of retraction ) with Active Tie back.

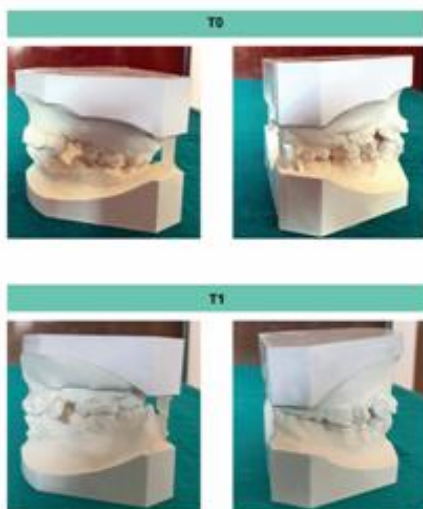


FIG-6

Cast analysis at T0 (Starting of retraction ) and T1 (After 4 months of retraction ) with closed coil spring.

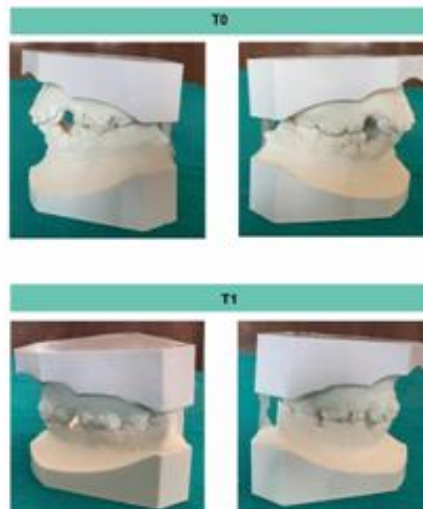


FIG- 7

Cast analysis at T0 (Starting of retraction ) and T1 (After 4 months of retraction ) with closed coil spring.

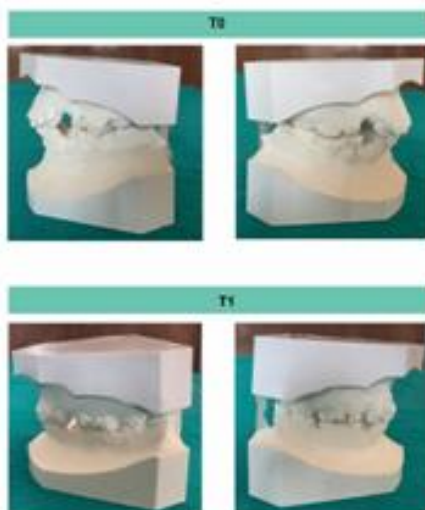
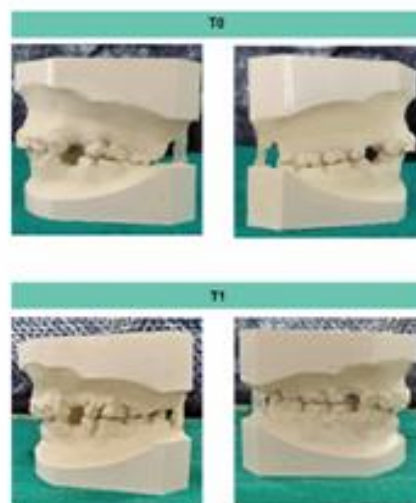


FIG-8

Cast analysis at T0 (Starting of retraction ) and T1 (After 4 months of retraction) with polyurethane power chain.





**Results:** The study included 20 sample specimens belonging to 4 groups based on the type of space closure method used.

Group 1- NiTi closed coil spring

Group 2- Active tie back

Group 3- Power E chain

Group 4- Mini screw with E chain

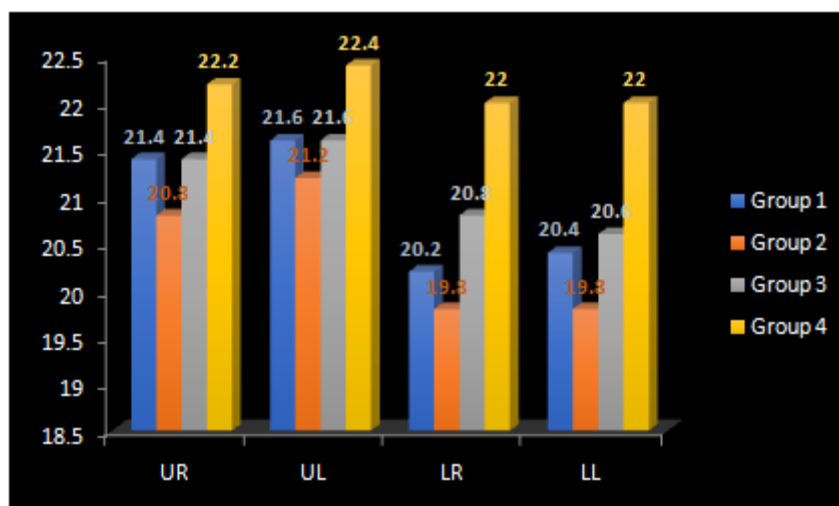
**Table 1.** Inter-group judgement of mean distance between cusp tip of the maxillary canine to the buccal cusp tip of first maxillary molar in maxillary arch and distance between cusp tip of the mandibular canine to the mesiobuccal cusp tip of first mandibular molar in mandibular arch of the specimens before the treatment.

	Group 1	Group 2	Group 3	Group 4	P value
UR	21.4±1.51658	20.8±1.64317	21.4±1.14018	22.2±0.83666	0.443
UL	21.6±2.07364	21.2±1.48324	21.6±1.14018	22.4±0.89443	0.631
LR	20.2±1.64317	19.8±2.38747	20.8±1.09545	22.0±1.22474	0.216
LL	20.4±1.94936	19.8±2.38747	20.6±1.14018	22.0±1.22474	0.277

The mean distance between the cusp tip of maxillary canine to the mesiobuccal cusp tip of maxillary first molar on right and left side did not differ significantly between the groups before the treatment ( $p$  value>0.05). Similarly, the mean distance between the cusp tip of mandibular canine to the mesiobuccal cusp tip of mandibular first molar on right and left side did not differ significantly between the groups before the treatment ( $p$  value>0.05).

**Graph1:** Inter-group comparison of mean distance between cusp tip of the maxillary canine to the mesiobuccal cusp tip of first maxillary molar in maxillary arch and distance between cusp tip of the mandibular canine to the mesiobuccal cusp tip of first mandibular molar in mandibular arch of the specimens before the treatment.



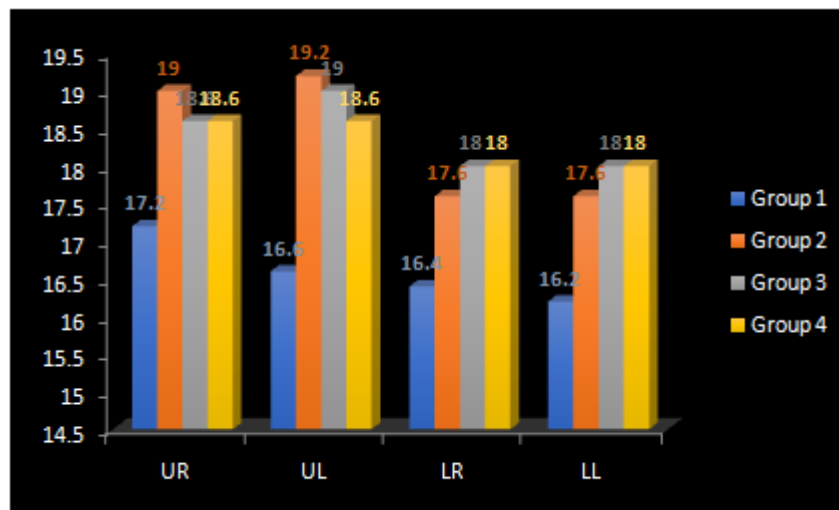


**Table 2.** Inter-group comparison of mean distance between cusp tip of the maxillary canine to the mesiobuccal cusp tip of first maxillary molar in maxillary arch and distance between cusp tip of the mandibular canine to the mesiobuccal cusp tip of first mandibular molar in mandibular arch of the specimens after the treatment.

	Group 1	Group 2	Group 3	Group 4	P value
UR	17.2±2.58844	19.0±1.87083	18.6±1.14018	18.6±1.14018	0.429
UL	16.6±1.81659	19.2±1.78885	19.0±1.58114	18.6±1.51658	0.095
LR	16.4±2.40832	17.6±2.30217	18.0±1.41421	18.0±1.41421	0.533
LL	16.2±2.16795	17.6±2.30217	18.0±1.41421	18.0±1.41421	0.400

The mean distance between the cusp tip of maxillary canine to the mesiobuccal cusp tip of maxillary first molar on right and left side did not differ significantly between the groups after the treatment ( $p$  value > 0.05). Similarly, the mean distance between the cusp tip of mandibular canine to the mesiobuccal cusp tip of mandibular first molar on right and left side did not differ significantly between the groups after the treatment ( $p$  value > 0.05).

**Graph 2.** Inter-group comparison of mean distance between cusp tip of the maxillary canine to the mesiobuccal cusp tip of first maxillary molar in maxillary arch and distance between cusp tip of the mandibular canine to the mesiobuccal cusp tip of first mandibular molar in mandibular arch of the specimens after the treatment.

**Table 3.** Post hoc analysis.

	UR	UL	LR	LL
Group 1 vs Group 2	0.004*	0.009*	0.183	0.075
Group 1 vs Group 3	0.162	0.040*	0.554	0.189
Group 1 vs Group 4	0.780	0.467	0.993	0.993
Group 2 vs Group 3	0.268	0.878	0.853	0.951
Group 2 vs Group 4	0.028*	0.157	0.116	0.121
Group 3 vs Group 4	0.597	0.467	0.404	0.286

Post hoc analysis revealed that the rate of space closure in group 1 was significantly more than that in group 2. The rate of space closure was non-significantly different between group 1 and group 3, group 1 and group 4, group 2 and group 3 and between group 3 and group 4 ( $p$  value  $> 0.05$ ).

**Discussion:** In our study which is conducted in Awadh Dental College and Hospital Jamshedpur, Jharkhand among the 20-sample patient, using 4 different techniques by using whole mouth technique which is similar to v Dixon study<sup>19</sup>, but in contrast to Samuel et al<sup>2</sup> where split mouth technique is used.

In this study before the treatment the mean distance between cusp tip of canine to mesiobuccal cusp tip of molar is approximately same and statistically non-significant. In our study mean monthly rate of space closure by NiTi closed coil spring is approximately 1.1 mm per month & 4.4 mm per four month (table 1), by active tie back it is approximately 0.5 mm per month & 2mm in four month (table 2), by power chain mean monthly rate is around 0.7mm/ month & 2.8 mm in four-month period & by power chain attached with mini screw is approximately 0.95mm and 3.80 in four-month period.

Clinically rate of space closure is faster in NiTi closed coil group which is similar to the study of V Dixon et al<sup>19</sup>, Samuel et al<sup>2,8</sup>, Sonis A.L.<sup>7</sup>, .H Mohammed<sup>20</sup>

After doing the post- hoc analysis (table 3) we can conclude that space Closure by NiTi closed coil spring is significantly more than active tieback. But when we compare the rate of space closure by active tieback & elastic powerchain it is statistically non-significant. Mean distance between Right and left side of maxillary and mandibular arch after the treatment is statistically non-significant.

Rate of space closure is more significant within the group in maxilla than in mandible. Clinically in my study rate of space closure is faster in decreasing order with NiTi closed coil spring, elastic power-chain attached with mini screw, the power chain and last active tieback but statistically this difference is non coincident.

In this study NiTi closed coil spring delivering 200 gm force for space closure is used. Similar to other study like V Dixon et al<sup>19</sup>, A range of 100-200 g is suggested sufficient by Quinn and Yoshikawa<sup>1</sup> and this was the force range observed in the review. It is not the magnitude of force applied rather its duration that is considered important for good biologic tooth response.

### **Conclusion:**

- Our study has shown that NiTi springs delivering 200gm forces gave the most rapid rate of space closure and may be considered the treatment of choice.
- Mini screw with polyurethane powerchain is best for anchorage and its rate of space closure is non-significant with polyurethane power chain but its rate of space closure is less than NiTi closed coil spring. But at the same time, it is expensive and require surgical exposure to the patient.
- However, power chain and active tieback provides a cheaper treatment & effective option.

In this study sample size was limited from Jharkhand population, to get other perspectives further more studies are needed with increased sample size.

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