Mesioangular impacted lower third molar angulation changes in non-extraction orthodontic treatment

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Abstract. The lower third molar is the most commonly impacted tooth, with higher prevalence in the mandibular and mesioangular angulation. In orthodontic patients, the observation of third molar impaction generally entails measurement of its angulation before and after treatment. This study aimed to determine mesioangular impacted lower third molar angulation changes in subjects with fixed orthodontic treatment in Teaching Dental Hospital, Faculty of Dentistry, Universitas Indonesia. 27 samples were selected and measured before and after treatment on panoramic radiograph using the Poosti method. The result showed an increase in angulation clinically on both sides of the jaw. Based on statistical analysis, however, these angulation changes were not significant (p > 0.05).

1. Introduction
During the process of growth and development of teeth, the last tooth to erupt is the third molar, and in clinical conditions, it is often found impacted or missing [1]. The third molar, according to Breik (2008), is the most commonly impacted tooth, comprising 58.76% [2] of all cases of impacted teeth. Hashemipour (2013) demonstrated that the most prevalent type of third molar impaction occurs in the mesioangular direction (48.3%) [3]. The formation, time of calcification, position, and direction of third molar eruption [4] all influence its development, which in consequence shows a great variability. Impaction can be caused by several etiologies, among them insufficient retromolar space [5]. With enough space, the third molar can erupt [6]. This process occurs between the ages of 17 and 21 years, and under normal conditions, the development of their roots is completed between the ages of 18 and 25 years [7].

The third molar is normally under observation during orthodontic treatment because of its incomplete growth and development and the possibility of angulation changes of that tooth. The existence of space during orthodontic treatment increases the likelihood of angulation changes occurring in the third molar. These spaces may be created by extraction or without extraction. Orthodontic treatment without extraction—non-extraction orthodontic treatment—is performed if a space less than 2.5 mm is needed [8]. Orthodontists can obtain space by interproximal enamel reduction, molar distalization, jaw expansion, and proclination of anterior teeth [9]. They can measure angulation changes of the third molar by comparing the panoramic radiograph before treatment with the panoramic radiograph after treatment. From that comparison, they can observe the process of...
changing the third molar to an upright position so as to erupt into the oral cavity. Panoramic radiography is preferred because measurement on lateral cephalometry radiograph can cause bias through the superimposed image from a different angulation [10].

Saysel (2005) and Jain (2009) conducted some studies to see the effects of orthodontic treatment against angulation changes of the third molar on extraction cases and non-extraction cases [11,12]. They found a decrease in dental angulation clinically in non-extraction cases when treatment was completed. In other words, the tooth position had become more vertical. This angulation improvement would have increased the possibility of eruption of the third molar, and extraction at the end of treatment can be considered. Russell (2012) showed that a quarter of non-extraction cases had increased angulation so that the third molar became indicated for extraction. However, that increase in angulation was not statistically significant [13].

In studies by Tarazona (2010) and Artun (2005), malocclusion was included in the inclusion criteria [14,15]. Silling (1973) did not recommend using classes II and III malocclusion because growth abnormalities of the jaw can cause bias [5]. In this study, we used class I malocclusion as an inclusion criterion. Angulation measurement of the third molar was performed by comparing the panoramic radiograph from the patient before and after the non-extraction orthodontic treatment.

2. Methods
This study was an analytic retrospective study with a cross-sectional design. This study aimed to identify the angulation differences before and after orthodontic treatment. Samples for this study comprised panoramic radiographs from patients' dental records at the Teaching Dental Hospital, Faculty of Dentistry, Universitas Indonesia. Samples were selected by using the non-random sampling techniques.

Inclusion criteria in this study were men and women above 12 years old with an impacted lower third molar in a mesioangular direction (5–65°) on both sides, who had received non-extraction orthodontic treatment for a fixed dental period, had class I skeletal malocclusion, and had no missing teeth. Exclusion criteria on this study were patients with dentofacial abnormalities, patients with congenital or syndrome disease, and patients who had an impacted third molar with the buccal version or the lingual version.

Angulation measurement of impacted third molars was done on panoramic radiograph before and after orthodontic treatment using the Poosti method. First, measurements were performed by tracing the third molar and second molar. Second, an occlusal line that passed the cusp of the third and second molars was created. Then, a perpendicular line against this occlusal line was created. In the final step, the angle formed between the second and the third molars was calculated.

All data of angulation changes were analyzed by the Shapiro–Wilk normality test. Because the data obtained were not normally distributed, non-parametric statistical tests of the Wilcoxon signed-rank type was performed. All statistical testing was performed using a significance level of 0.05 and confidence degrees of 95%.

3. Results
Twenty-seven samples, comprising 23 females (82.5%) and 4 males (14.8%) fulfilled the inclusion criteria. All subjects were aged above 12 years based on inclusion criteria. The average age of the subjects was 15.89 ± 3.04 years. The youngest subject was 12 years old, and the oldest subject was 22 years old. Age distribution was divided into two groups—the group aged 12–17 years and the group aged 18–22 years.

In the right-side group, there was an average increase of third molar angulation (3.8°). This was evident in the pre-treatment results of the right side that had an angulation average of 27.9 ± 9.59° bounded by a lower value of 13° and a higher value of 52°, whereas at post-treatment, they had an angulation average of 33.5 ± 15.95° bounded by a lower value of 10° and higher value of 75°.
In the right-side angulation group aged between 12 and 17 years, there were 11 samples (57.89%) with increased angulation, 7 samples (36.84%) with decreased angulation, and 1 sample that still had the same angulation after orthodontic treatment was completed. In the group aged 18–22 years, five samples (62.5%) had increased angulation and three samples had decreased angulation after orthodontic treatment was complete. We concluded that there was increased angulation on the right side after the completion of orthodontic treatment on these two differently aged groups.

On the left side, angulation had also increased by an average angulation of the third molar of (0.81°). On the left side, the pre-treatment group had an average angulation of 30.78 ± 11.37° bounded by a lower value of 6° and higher value of 47°. The left-side post-treatment group had an average angulation of 31.59 ± 18.05° bounded by a lower value of 0° and a higher value of 85°. A value of 0° means that the third molar erupted successfully.

In the left-side angulation group, aged 12–17 years, there were 11 samples (57.89%) with increased angulation and 8 samples (42.11%) with decreased angulation after the completion of orthodontic treatment. In the group aged 18–22 years, there were four samples (50%) with increased angulation and four samples (50%) with decreased angulation after the completion of orthodontic treatment. We concluded that there was increased angulation on the left side after the completion of orthodontic treatment in both of these two groups of different ages.

Before performing the statistical tests, we tested for normality of data with the Shapiro–Wilk test. These results show that distribution of data was not normal, so we performed the non-parametric statistical Wilcoxon signed-rank test. Based on these statistical analyses, the p value on the right-side angulation was 0.121 and the p value on left-side angulation was 0.782 (Table 1). Because both of these p values >0.05, there were no statistically significant differences of angulation between the period before and after orthodontic treatment.

| Angulation | Time | N  | Average | Minimum | Maximum | Deviation Standard | P Value |
|------------|------|----|---------|---------|---------|--------------------|---------|
| on right side | T0   | 27 | 29.70   | 13      | 52      | 9.59               |
| on left side | T1   | 27 | 33.50   | 10      | 75      | 15.95              | 0.121   |
| Angulation | T0   | 27 | 30.78   | 6       | 47      | 11.37              | 0.782   |
| on left side | T1   | 27 | 31.59   | 0       | 85      | 18.05              |

4. Discussion
The subjects of this study were above 12 years old because the germ of the third molar has been well seen on panoramic images at this age [16]. On the basis of a study by Popescu (2008), on average, the germ of the third molar can be seen at 9 ears 5 months [17]. At that age, the germ existed in hard tissue synthesis [7]. This was, however, too early for it to be seen on panoramic images. Before the onset of treatment, the germ of the third molar must be in the enamel synthesis stage [14], a process that has begun by the age of 12 years [7].

Another inclusion criterion was class I skeletal malocclusion. The same criterion was also used in previous studies by Salehi (2008), Saysel (2005), and Poosti (2012) [11,18,19]. Under normal jaw relationship conditions, the third molar may be well erupted. Otherwise, in the class II and class III jaw relationship condition, the probability of the third molar being impacted becomes higher because of abnormalities in jaw growth factor [5].

Two types of panoramic images are available in the dental records of specialist clinics—the original panoramic images and digital panoramic images. Original panoramic images are traced over
acutated on the basis of the Poosti method. Digital panoramic images are printed by researchers using photo paper and then also traced over acetate paper and the angulation calculated on the basis of the Poosti method same with original panoramic radiographs. The calculation of digital panoramic radiographs does not use the viewer. Although conducted in two different machines, the measurement result does not change because the measurement is angular.

This study found that there was an average increased angulation of the third molar. This indicates that in general the condition of impaction worsens after the completion of treatment. This result is consistent with that of other researchers—such as Russell (2012), Kaplan (1975), Dierkes (1975), and Poosti (2012)—who found that non-extraction orthodontic treatment was associated with increased frequencies of third molar impaction and decreased eruption of the third molar [11,18,20,21].

There are three suspected possible causes of angulation changes of the third molar. The first possible cause is rotation movement before eruption. The third molar position will change at the age of 14–15 years [10]. Another study by Shriller (1979) shows that changes in the position of the lower third molar can occur up until the age of 20 years [22] Artun (2005) proposed that angulation changes of the third molar commonly occurred until the final step of root formation had been reached (at the age of 18–25 years) [15]. This was confirmed in the study results—especially in the group aged 12–17 years. There was increased angulation on both sides. In the group aged 18–22 years, there was increased angulation only on the right side. The division of these groups was based on the growth pattern of the third molar. Enamel and crown formation of the third molar occurs at the age of 12–17 years. Root formation or root enhancement occurred at the age of 18–22 years.

The second possible cause was pressure during the mastication process. In patients with a habit of chewing only on one side, it may cause interproximal wear, which creates a space. Consequently, the tooth will move toward that space [18]. This condition, however, cannot be included in our interpretation of this study, because it is unknown whether the patients had a chewing habit on one side or not. Russell (2012) stated that if there was additional space on the jaw, the third molar could move more vertically and that would increase the possibility of eruption [13]. In non-extraction orthodontic treatment, an increase of space may be obtained by methods such as interproximal enamel reduction, molar distalization, jaw expansion, and proclination of the anterior teeth [9].

The third possible cause was mechanical appliances used for orthodontic treatment, such as the appliance used for molar distalization. This appliance can affect the rotation movement before eruption of the third molar so that its eruption becomes abnormal—thereby increasing the probability of the third molar becoming impacted [5].

Ahmed (2011) stated that the possibility of a tooth erupting existed only if initial angulation was at least 30°. This implies that the smaller the initial angulation, the greater the chance of the tooth erupting [10]. In samples of this study, 8 of 17 teeth on the right side and 8 of 12 teeth on the left side had an initial angulation below 30° and had decreased angulation. One of them had initial angulation of 14° in the initial treatment and had become 0° by the end of treatment. On the other hand, it could be said that the tooth erupted successfully. The eruption of a tooth is influenced by the class and position of the impacted tooth before treatment, the patient's age, and root formation. The impacted tooth had class I impaction so there was a sufficient space between the distal surface of the second molar and the ramus of the mandible. An impacted tooth has a position of impaction because the superior part of the tooth is located in a line with the occlusal line. Because of both these factors, there was increased chance of a third molar erupting. Other influences were the patient's age (19 years) and root formation, which had reached only 2/3 of its apical development at initial treatment. Corresponding with Artun's study (2005), angulation changes of the third molar can occur at the final stage of root formation [15].

The result from the Wilcoxon signed-rank test (one of the non-parametric tests) showed that the angulation changes of the third molar on each side between before and after non-extraction orthodontic treatment were not significantly different. These conclusions regarding non-extraction orthodontic treatment were the same as the results of a study by Jain (2009) and Russell (2012)
5. Conclusions
There is increased angulation of the impacted lower third molar with a mesioangular position on both sides of the jaw from before and after non-extraction orthodontic treatment. On the right side of the jaw, there is increased average of angulation and the prevalence of angulation is higher than on the left side of the jaw. On the basis of statistical analyses, there was no significant angulation differences in the lower third molar before and after non-extraction orthodontic treatment.

6. References
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