The Effect of Platelet-Rich Plasma to Orthodontic Tooth Movement

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Abstract—Platelet-Rich Plasma already used by oral surgeon and periodontics due to enhance the bone remodels. Orthodontic tooth movement affects bone remodeling process, bone resorption on the pressure side and new bone formation on the tension side. This is the objective of this research, to observe the effect of PRP to orthodontic tooth movement. This research was conducted in pure clinical experimental to Guinea pig. Nineteen Guinea pigs separated into two groups, control and PRP groups. Blood homologue from donors was processed became PRP and the highest platelet counted number injected to samples without activator. 4 times measurements were studied: 6, 9, 12 and 24 days of orthodontic tooth movement by rubber separator between central incisors. Distance between central incisors was measured with digital caliper (0.01 accuracy). Platelet mean measured were 430,004.57.32 (10^3/mL). Distance measurements were not significantly different between PRP and control groups at each time point of measurement (p > 0.05) with t-test unpaired analysis, and neither does analyzed with mixed-repeated measured ANOVA (p=0.935) but analysis between 4 times point of measurement but there were statistically significant effects of time simultaneously for each groups.

Keywords—platelet-rich plasma, orthodontic tooth movement, guinea pig

I. INTRODUCTION

Tooth movement physiology has two sides mechanism, pressure area which is the bone compressed by loads of the mechanical force of orthodontic appliance. Resorption happened at this pressure or compression side of the alveolar bone and periodontal ligament which will activate PDL progenitor cells to differentiate into osteoclast [1,2]. In the other side, as a response to the deformation, the tension area which is the apposition area activates fibroblasts and osteoblasts in the PDL as well as osteocytes in the bone to localized apposition to alveolar bone [1].

The phenomenon of molecular biology and genomes for tooth movement and stabilization in orthodontic treatment are complex. In the beginning from coordination of biochemistry reaction around cells, protein expression pattern, cells synthesize, cell divisions, cell proliferation until cells differentiated have vary every patient [1,3,4]. Cell synthesizes and molecular release such as neurotransmitter, cytokines, and growth factors (GFs), colony stimulating factors, arachidonic metabolic acid [2].

Orthodontics’ mechanical low force and accelerated tooth movement now become a trend topic discussed generally. The longer the treatment the more gets negative effects on oral hygiene, root, alveolar and gingival embrasure resorption [5-7]. Wilcko found a method of surgery procedure to provide a periodontal ligament-mediated acceleration in tooth movement reducing some thin layers of an alveolar and many more researchers tried to find methods to accelerate tooth movement [8]. Brahmanda’s researched was a hyperbaric oxygen therapy as an adjuvant for orthodontic, Nishimura tried to use vibration on teeth before treatment, Xue et al., with LIPUS (low intensity pulsed ultrasound) and the last was Gulec et al., and Liou with the injected platelet-rich plasma (PRP) to induce the teeth movement [7,9-12].

Platelet-rich plasma (PRP) is a processed by centrifuging blood autologous product derived from whole blood [11,13]. Platelet-rich plasma (PRP) is an easily accessible source of growth factors to support bone and soft-tissue healing by increasing cellular proliferation, matrix formation, osteoid production, connective tissue healing, angiogenesis, and collagen synthesis [13,14]. Platelet-rich plasma (PRP) has been well known specially in preparation for a dental implant or promoting an alveolar bone by periodontologist [15].

Growth factors and other substances served to accelerate the wound-healing process [13] while others...
found no additional benefit [16]. Graziani et al., mentioned that PRP can play an inhibitory role in bone metabolism in a concentration-dependent fashion [4] so that PRP could be succeed in accelerating tooth movement in rats by reducing the bone density [11] and accelerating tooth movement in human [12]. The clinical usefulness of PRP remains controversial especially for orthodontic tooth movement [17]. There were still a few research mentioned about PRP effects to orthodontic tooth movement especially for human.

Therefore the purpose of this research were to observe PRP sub mucous injection to orthodontic tooth movement in guinea pig which it has resemblance to human so that we can analyze the bone remodelled in histology analysis [18].

II. MATERIALS AND METHODS

This research was a clinical experimental analytic research. The clinical experimental study with 24 young Guinea pigs (2-3 months) with mean of weight 250-400 grams. There were nurtured at Biology Department of University Sumatera Utara for two months. This study was approved by the Animal Research Ethics Committee (AREC) at Biology Department of Mathematics and Natural Science Faculty (protocol approval number 497/KEPH-FMIPA/2017), University of Sumatera Utara, Medan Indonesia.

Guinea pigs were divided into three groups: donor group (euthanized for the preparation of PRP; n 4), control group (C group, n 10), and platelet-rich plasma injection group (PRP group, n 10-1). These 2 groups, 4 time points were studied on days 6, 9, 12, and 24. The animals were fed with chopped carrots diet to prevent the pulled out of the rubber separator. All procedures were completed under general anesthesia with intramuscular injection administration, donor groups was euthanized with pure ketamine (150 mg/kg) without xylazine which didn’t distribute in Indonesia recently [18].

The production of PRP began with a 9-12 mL homologous blood sample from the donor animal via cardiac puncture. Blood withdrew from cardiac directly to 1.8 or 2.7 ml tube which contained a buffer Natrium citrate 3.2% as an anticoagulant. 0.5 ml whole blood sample set apart and analyzed for observe the concentration of whole blood test analysis such as red blood cell analysis, platelets and leukocytes in whole blood with an analyzer blood machines (sysmex XT-2001). The blood sample was centrifuged with Eppendorf centrifuge machine at 1500 rpm (264 rcf) for 5 minutes to process the whole blood become platelet rich plasma. Plasma was drawn off the top and one per four plasma in the bottom separated from red blood cell has been moved to the new spuit needle which contained the buffy coat of PRP product. Platelet in plasma as PRP concentration then analyzed again with the same machines. The mean difference was then calculated and the highest platelets in PRP concentrate was then injected to the guinea pig fresh after processed. Other PRP sampled were brought to store at -80°C freezers for future biochemical analysis.

Force for orthodontic tooth movement was given by power-O (Ormco) as a rubber separator between central incisors after PRP injection. Power-O changed gradually every 4 times point of measurements. Measurement for tooth movement distance was done 5 minutes after removing the rubber separator as a biological adaptation after orthodontic force released. Comparison was made between control group and PRP group to compare the distance effects for each different time points measurement.

The data were processed with IBM*SPSS Statistic (version 21). The results are expressed as means and standard deviations, dependent t-test analysis to compare inter-rater reliability data for tooth movement distance, independent t-test analysis to compare two groups variable for each time point of measurements, and also one-way repeated measures analysis of variance was used in repeated measurements for each of two groups for all 4 times point and also mixed-ANOVA for analyzed correlation between two groups and 4 time point of measurement. The significance level was set at P <0.05.

III. RESULTS

In the beginning of trials, The sample consists of 2 groups divided into 10 samples for control groups and 10 samples for trial groups (PRP groups). Before day 12, one sample was excluded due to unhealthy and dead.

The mean for platelet’s count in whole blood cells from 4 donor samples were 223.25 ± 33.69 (10^3/µL) and the mean for platelet’s concentration count in Platelet rich plasma were 430.00±57.32 (10^3/µL). The platelet’s count raised 1,93 fold by single centrifugation method. The platelet concentration’s for PRP injection to all samples at PRP group were 507.00 (10^3/µL) which had 2,45 fold platelet’s counts numbers.

The inter-rater correlation coefficient differences values between two observer were above 0.057 for all groups of 4 times point of distance measurements at day 6, 9, 12 and 24, confirming the reliability of the measurements. The tooth movement increased high at day 6 from the base line and also gradually increased from day 6 to day 9 for both groups and day 9 to 12 only at PRP group (Figure 1). It seemed slower at day 9 to 12 for the control groups and day 12 to 24 for both groups.

At Table I, statistically compared between both groups for each time point of measurement (analyzed with unpaired t-test) found that there were not any of the each time measurement had significantly different with the smallest p value were still 0.054 (p>0.05) at day 12. It seemed the tooth movement in PRP groups still increased while in control group was already stabilized.

Another statistically analysis were a mixed-repeated measured of ANOVA, neither found significantly main
effect of intervention (PRP injection on PRP group) than control group with p value 0.935 (p>0.05).

As if we analyzed for each groups, there were found statistically significant at least for three time points measurements at each groups with Greenhouse-Geisser correction (F(2,132;36,243)=3,464, p<0.039).

TABLE I. MEAN OF DISTANCE’S MEASUREMENT OF TOOTH MOVEMENT FOR PRP INJECTION

<table>
<thead>
<tr>
<th>Group</th>
<th>Distance of Tooth Movement (mm)</th>
<th>Day 6</th>
<th>Day 9</th>
<th>Day 12</th>
<th>Day 24</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Groups</td>
<td></td>
<td>0.840</td>
<td>0.956</td>
<td>0.976</td>
<td>1.046</td>
<td>0.001</td>
</tr>
<tr>
<td>PRP Groups</td>
<td>(n=10)</td>
<td>±0.063</td>
<td>±0.034</td>
<td>±0.042</td>
<td>±0.054</td>
<td></td>
</tr>
<tr>
<td>PRP Group</td>
<td>(n=9)</td>
<td>0.777</td>
<td>0.948</td>
<td>1.026</td>
<td>1.061</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.113</td>
<td>±0.085</td>
<td>±0.061</td>
<td>±0.049</td>
<td></td>
</tr>
<tr>
<td>P*</td>
<td></td>
<td>0.162</td>
<td>0.792</td>
<td>0.054</td>
<td>0.534</td>
<td>0.935</td>
</tr>
</tbody>
</table>

* Unpaired T-test. *Repeated measured ANOVA. *Mixed-ANOVA

In conclusion to this research, we couldn’t see any significantly different between both groups with 4 time points of measurement but there were statistically significant effects of time simultaneously for each groups. It still needs further studies to continue this research.

ACKNOWLEDGMENT

Acknowledgments are addressed to Research Institution University of Sumatera Utara at the expense of this study from TALENTA funding in 2017.

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