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The Research Progress of Platelet-Rich Fibrin Applications in the Orthodontic Treatment

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Abstract. Either the alveolar bone defects or the severe absorbed alveolar bone led by the teeth extraction could have an effect on the orthodontic teeth movement. Guided bone generation technique has supplied a new method for the above clinical difficulty. Platelet-Rich Fibrin has been reported in the orthodontics and clinical researches because of its obvious osteogenic property. This paper was to describe the newly applications of Platelet-Rich Fibrin in orthodontic clinic.

In the orthodontic clinic, the alveolar bone defects or the height and the decreased width of alveolar bone always occurred due to the common reasons such as tumor, inflammation, the early loss of teeth, extraction or cleft lip and palate, which would have negative effect on the orthodontic teeth movement. For example, the teeth would not move or have a lot of difficulties in moving, the roots of teeth could be absorbed and the alveolar bone around the teeth would be resorbed 1. The above complications would jeopardize stability of the orthodontic treatment results. Nowadays, the development of Guided Bone Regeneration offered a new method to solve the above mentioned difficulties. Platelet-Rich Fibrin has been more noticed in the bone reconstruction because of its obvious osteoinducivity and osteoconductivity properties. At present, there are many studies about Platelet-Rich Fibrin used in the orthodontic fundamental researches and clinical application. This paper was to describe the newly applications of Platelet-Rich Fibrin in orthodontic clinic.

The Influence on Teeth Movement Made by Alveolar Bone Changes after Teeth Missed

After tooth extraction, the rest alveolar bone would be remodeled and absorbed because of lacking the normal teeth physiological stimulation. Schropp et al 2 observed changes taking place following tooth extraction in humans. He reported the width of the alveolar ridge reduced up to 50% during the 12 month observation period after the extraction. This loss corresponded to a buccal-lingual change in dimension of 4.5 to 6.1 mm. The finding that approximately two thirds of this reduction occurred within the first 3 months after tooth extraction. Horrowitz et al 3 have reported that at the first 3months, the buccal alveolar resorption percent was about 56%, the lingual alveolar resorption percent was about 30%, the buccal resorprion was obvious larger than the lingual alveolar resorption percent. Misch 4 proposed that the loss of crestal bone height and width of the buccal plate after tooth extraction is partially due to the constriction of the blood clot in the alveolus, and the remodeling of the labial cortical plates in response to inadequate blood supply after the extraction, which is consistent with the results make by Horrowitz. The vertical alveolar bone resorption was on average 0.5 to 0.9mm. The changes of the height and wodth of alveolar bone after teeth were missed increased the difficulties of the orthodontic teeth movement. Lindskog Stokland B et al 5 have reported that when the teeth moved to the edentulous area, two situations would can be seen. One was that the teeth moved slowly and the buccal bones would be absorbed. The other situation was that when the teeth contacted the buccal bones, the resorption incidence of lateral roots on the pressure side of orthodontically moved teeth was about 50%. After one year retention, the resorpted roots would be repaired by itself potential repair ability.

The Influence on Teeth Movement Made by Soft Tissue Changes after Teeth Missed

In the orthodontic treatment, there would always be noticed that gingival invaginations hindered the orthodontic teeth movement during the long distance space closing. Gingival invaginations are defined as a cleft of the alveolar process with vertical and horizontal probing depth of at least 1 mm, occurring after tooth extraction and subsequent orthodontic space closure, which is normally defined as the gingival "pseudo blind bag"6 . Their incidence is given no less than 30%. Though the incidence of gingival invaginations was high, the reasons were not unclear. At present, there were two main hypotheses; one was that the presence of gingival invaginations might be related to the edentulous alveolar anatomy morphology. Diedrich and Wehrbein 7 have revealed that the longer time the teeth were misses, the higher incidence of gingival invagination, which is mainly due to the alveolar bone resorption. Rivera Circuns and Tullochs' research 8 indirectly supported the above mentionned, in which the conclusion showed that the speed of mandibular space closing was lower than that in maxillary. So the mandibular gingival invagination incidence was higher than the maxillary gingival invagination incidence. Li Fang et al 9 has reported that the mandibular was easier to be noticed the gingival invaginations than the maxillary. Gingival invaginations were relevant to the teeth movement distance, not to the gender and age. The other one hypothesis was based on the mechanical factors that the discrepancy between the tension side and the pressure side during the orthodontic space closing.

Lindskog Stokland B et al 5 have concluded that there was obvious difference between the tension side and the pressure side when the teeth moved to the edentulous area. The most marked change at time of retention was noted with regard to apical displacement of the gingival at the tension side of the moved teeth. On the pressure side, on the other hand, a slight increase of soft tissue height was noticed at the same time. After 1-year rentention, all tooth sites gingival showed a mean apical displacement compared to pretreatment status.

Platelet-Rich Fibrin Applications in the Orthodontic Treatment

During the orthodontic treatment, the sufficient bone can assure the orthodontic teeth move in the cancellous bone and avoid the side effects such as teeth roots resorption and the alveolar cleft due to the bone resorption in the width and height of alveolar bone. The augmentation method for the width and height of alveolar bone is Guided Bone Regeneration-GBR. The growth factors can improve the bone, soft tissue healing and accelerate angiogenesis. Platelet-rich fibrin constitutes of many kinds of growth factors, which make it have the obvious properties of osteoconduction and osteoinduction. More and more scholars noticed that PRF has the definite effects on the bone formation.

The biological construction characters of the Platelet-Rich Fibrin. PRF has been popular for its unique fiber construction, abundant platelet and plentiful growth factors. PRF belongs to the second generation of platelet concentrate. Compared to the first generation platelet concentrate (PRP), its preparation is easier and simple. There was no need in heating, in adding the additional materials as the anticoagulants (nor bovine thrombin, nor any other gelling agents) or the second centrifugation.

The fibrin architecture can protect the growth factors from the protease hydrolyzing, and the PRF membrane can release high quantities of growth factors, such as transforming growth factors TGF-b 1, platelet-derived growth factor PDGF- ab , vascular endothelial growth factor VEGF and TSP-1 and so on. In vitro, there was a research tested the quantities of the 3 main growth factors(TGFβ, PDGF-AB and VEGF) at the seven different experimental time(such as 20 minutes, one hour, four hours, twenty-four hours, 72 hours, 120 hours and 168 hours). The results showed that the PRF membrane can keep the solid form and release the growth factors consistently after 7 days 10.

The growth factors in PRF can stimulate the angiogenesis and have the effect of biologic characteristics on proliferation and differentiation of cells. In a PRF clot there are many cytokines included: inflammation cytokines, such as IL-6, IL-1β, IL-1, TNF-α , and healing cytokines, such as IL-4 and VEGF. These components are the reason why PRF has anti-inflammatory properties, as

well as it accelerates angiogenesis and creation of fibroblasts and osteoblasts, the consequence of which is the enhanced healing process 11, 12. Yelamali et al reported that PRF is significantly better in promoting soft tissue healing; also decrease the pain after third molar extraction 13. The above results were consistent with that researched by Hauser et al 14and Kumar et al 15.

In the physical property of PRF, PRF can't be injected because it has certain volume and shape so PRF can exist in form of solid. This is different from the first generation platelet concentrate-PRP, which could be injected to use. As result, the solid form of PRF could be combined with the major surgeries, protect the wound healing as biomaterials or membrane and have better operation.

Platelet-Rich Fibrin Applications in Alveolar Ridge Preservation. Alveolar Ridge Preservation technique is to take some efforts to minimize the resorption of hard tissues as soon as possible at the time of extraction or immediately after the extraction. So it can offer enough bone and aesthetic effort to support the lateral prosthetics. This concept was first put forward basing on the implantation application. Its purpose was to preserve the morphology of hard tissues around the teeth sockets, to prevent the alveolar resorption process, to improve the bone condition for implantation sites and to make better prosthetic aesthetic efforts 16. During the orthodontic treatment, more and more scholars put Alveolar Ridge Preservation technique into the orthodontics to prevent the bone resorption process after teeth extraction, to decrease the difficulty of orthodontic teeth movement, to avoid the risks of roots resorption, the alveolar bone cleft and gingival invagination and to prevent the inadequate alveolar bone during the orthodontic space closing.

Alveolar Ridge Preservation technique had applied the bone grafting bone materials into the teeth extraction sockets, and the extraction sites were covered by the absorbable or non-absorbable biological barrier membranes 17. Various bone grafts and substitutes have been suggested for grafting of the postextraction socket, such as autografts, allografts, xenografts and alloplastic grafts 18. All the above bone grafting materials could decrease the bone resorption process, but the bone formation efforts were different because of lack vascular during the bone remolding. With the development of bone regeneration of biotechnology, new bioactive methods had been applied into the clinic, including the first and the second platelet concentrates (PRP and PRF).

Andreas Anwandter et al 19 have reported that the bone formation in the experimental group filled with PRF was better than that in the control group filled with alloplastic grafts. The above dates showed better bone formation when compared with those reported in a recent systematic review by Jambhekar et al 20 who analysed the outcomes of ridge preservation with different bone grafting materials. The results made by Andreas Anwandter et al 19 showed that PRF has a beneficial effect in reducing dimensional changes in comparison with natural healing, mainly because of its inherent bioactive capacity as it favours tissue regeneration. Compared with the natural healing, the new formed bones had been calcified after the Alveolar Ridge Preservation filled with PRF 4 months later. Jambhekar et al 20 have demonstrated that the amount of remnant graft material was highest for sockets grafted with allografts (21.8%), followed by xenografts (19.3%) and alloplasts (13.7%). Because PRF is an autograft of blood origin, it does not leave residual particles in the preserved sites.

Platelet-Rich Fibrin Applications in Guided Bone Regeneration. In the experimental and clinical studies, PDGF has always been used for bone defects, but nowadays it had not been reported that PDGF can be used in accelerating angiogenesis. VEGF has the effects not only on angiogenesis but also on chemotaxis and proliferation of osteoblasts 21. So when the autogenious PRF was added into the bone grafting materials, it could create better consequences. Platelet-rich fibrin was more and more widely used in the remolding of bone defects because of its unique biological structure characters. Su et al 22 have revealed that PRF membrane needs to be used immediately after preparation so as to maximumly releases the growth factors for the surgical sites. Choukroun et al 23 have reported that PRF seemed that it can't have positive impact on the proliferation of osteoblasts in the long run, but it can accelerate angiogenesis during the bone formation of grafting materials. The study has also reported that the PRF shortened the healing time when added into the Maxillary Sinus Lifting. Lee et al 24 have concluded that using PRF combined

with autogenious bone grafting were better during the bone formation than merely using autogenious bone grafting in their animal experiment. Park et al 25have concluded that the PRF combined with alloplastic grafting (β -tricalcium phosphate)can create better bone formation than that formed by PRP combined with alloplastic grafting(β -tricalcium phosphate) in their rabbit skull defects experiments. Many reports 26 have revealed that PRF have positive effects on the bone formation. Otherwise, Jong-Suk Yoon et al 27have revealed that PRF may increase the number of marrow cells but PRF along with xenogenic bone substitutes does not show a significant effect on bony regeneration when comparing the PRF along with xenogenic bone substitutes (Bio-oss) with merely PRF in rabbit cranial defects. Tongwen He et al 28 set up four groups so as to respectively observe the bone formation of PRF, PRP, PRF along with Bio-oss and PRP along with Bio-oss, they have concluded that PRF had better bone formation than PRP, PRF showed a significant effect on the early bone formation. Besides, PRF along with Bio-oss created better bone formation than PRF in repairing the rabbit's cranial defects.

Problems and Prospects. Platelet-rich fibrin supplied a new method for resolving the difficulties that the orthodontic teeth moved difficultly because of the severe alveolar bone resorption during the orthodontic treatment. Otherwise, the reports about the PRF used in the orthodontics mostly are animal experiments, the clinical studies are little. The use of PRF combined with bone grafting materials makes the bone augmentation possible, but there are still doubts that it could have impacts on the speed of orthodontic teeth movement, the movement distance or the movement patter. So we need explore more studies aiming to resolve the above problems.

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