

CHAPTER II

LITERATURE REVIEW

The orthodontic mini implant (OMI) is an alternative wisely device which is invented in the passing years to be used as a temporary anchorage for orthodontic treatment. The OMI are commonly used in the posterior regions of the mouth for tooth uprighting, retraction, extrusion, intrusion and stabilization. For anterior region, mini implants are typically used for intrusion, retraction and stabilization of teeth (Park *et al.*, 2002; Kim *et al.*, 2006). Carrillo and coworkers reported that mini-implants were effective for intruding both anterior and posterior teeth (Carrillo *et al.*, 2007a and b). However, there are several factors related to the clinical application of mini-implant. Importantly, the stress and strain distributions around the bone effected on mini-implant stability or implant displacement and increased the risk of peri-mini-implant bone resorption.

The effect of bone type and bone thickness is one of the most important factors which influenced the mini-implant stability and stress distribution. In the maxilla, the mean cortical bone thickness (CBT) was below 1 mm at the 6 mm location while at the 9 mm and 12 mm locations, the mean cortical bone thickness varied from 0.78 mm to 1.31 mm. There was a wide range of measurements in the mandible from 0.62 mm to 3.65 mm with the majority of the means over 1 mm. Whereas the mandible overall had more thickness of the cortical bone than the maxilla. (Moon *et al.*, 2008) With regard to the jaw and OMI applicable success rate, Park and coworkers (2005) reported that the maxilla had a higher success rate than the mandible. In the year 2009, Motoyoshi and his colleagues studied about the relationship between cortical bone thickness (CBT) and the stability of OMIs as well as the stress distribution in surrounding bone. CBT was evaluated in sixty-five orthodontic patients and the directly proportion of CBT to the success rate of OMIs was found. It was significantly greater at the sites with $CBT \geq 1.0$ mm. For the CBT less than 1.0 mm, the stress distribution was increased, especially in the bone model without cancellous bone underneath, and the failure rate was high. They concluded

that greater CBT values were associated with higher success rate of OMI. This morphometric study and mathematical simulation verified that a clinical CBT of 1 mm improved the success rate of mini-implants (Motoyoshi *et al.*, 2009a).

However, the phenomenon of bone response to a foreign insertion, such as an implant, has not been studied adequately and long-term effects of such stresses are still unclear. A thorough understanding of this phenomenon might lead to a reduction in the undesirable stress within the jawbone. Bone is a self-adaptive material which means that when the surrounding stress is changed, the bone tissue structure is adjusted by itself to suit the new loading environment so-called bone remodeling. Such remodeling altered the bone shape and changed of normal biological stress. Thus bone remodeling is the most important factor causing implant failure. Using the finite element method (FEM) and parameterised optimum design techniques can be decrease the failure rate of implantation.

Finite element analysis (FEM) has been proven to be a precise and applicable method for evaluating dental implant systems, including the OMI. The FEM is a numerical method of analysis for stresses and deformations in structures of any given geometry. The FEM has become one of the most successful engineering computational methods and most useful analysis tool since the 1960s. It is showing overwhelming capability and versatility in its application in dentistry. Future research directions are also recommended with particular emphasis on the stress evaluation and design optimization associated with the implants (van Staden *et al.*, 2006). Together with FEM, OMI would be evaluated to be more accurately and more precisely in clinical application.

Additionally, different types and designs of OMI have dissimilar effects on biomechanical parameters. The amount of force and vector for orthodontic tooth movement obviously related to mini-implant success rate. There was a related study in 2005 about the biomechanical effects of abutment on stability of OMI. Six types of finite element models were designed to show various thread pitches from 0.5-1.5 mm. Three models were designed with abutment and three other models without abutment. A traction force of 2 N was applied to the head of OMI or abutment at 45° to the bone surface. The results showed no remarkable differences were observed in the stress distribution patterns regardless of thread pitch variance. However, the stress

distribution was obviously different between model with and without abutment. High-level stress was remarkably smaller in the models with abutment. However, most of the high-level area was localized to the head of the implant. This report concluded that the existence of the abutment is significantly useful in decreasing the stress concentration on the surrounding bone, while the effect of thread pitch was uncertain (Motoyoshi *et al.*, 2005).

As the importance of the stress and strain distributions on OMI, three OMI models including AMI (ADTEC, Thailand), Jeil (Jeil Medical Corp., Korea) and Forestadent (Forestadent, Germany), with a diameter of 1.6 mm and 6 mm length, will be evaluated by means of a comparative FEM in different loading forces and angles. The hypothesis of this study is no significant difference of the stress and strain distributions between Thai OMI and commercial OMI.