CHAPTER 6
CONCLUSIONS

Since Kanomi (1997) introduced the clinical application and surgical procedure for using the mini-bone screw to providing maximum orthodontic anchorage, miniscrew implants in vary designs, sizes and composition of materials were manufactured and reports of clinical applications were increased continuously from 2003 to the present time (Chang *et al.*, 2004; Herman *et al.*, 2006; Lee *et al.*, 2004; Suzuki and Suzuki, 2007; Yao *et al.*, 2005).

The most frequently used sizes and designs of miniscrew implants were analyzed. Although selection of miniscrew implants depended on anatomical limitations and clinical applications, no standardization for screw selection in terms of diameter, length or shape was observed. Further studies are necessary to evaluate how the differences in size and shape are related to the biomechanical properties of the miniscrew implants.

Loading forces applied to miniscrew implants varied depending on different surgical procedures and biomechanics of tooth movement. However, a few studies of success rate reported that there was no significant difference in success rates among these varied loading forces. Therefore, further studies should be conducted to clarify the optimum loading protocol.

Previous studies of conventional skeletal anchorage, such as dental implants, suggest that inappropriate stress distribution in dental implants and bone is an important factor in bone resorption and implant failure (Melsen and Lang, 2001). Because bone has mechanical properties different from those of the dental implant, such as lower Young's modulus of elasticity and tensile stress, consequently if excessive loads are applied, the bone surface will fail first, rather than the implant surface. The distribution of stress in the dental implant itself can cause fatigue and failure inside the material (Skalak, 1983). Moreover, Sanches-Garces *et al.* (2004) concluded that excessive mechanical stress and microbial infection lead to peri-implantitits, followed by implant failure.

In the past three decades, the finite element method (FEM) has increasingly become a valuable tool for the prediction of the effects of stress and strain on dental materials and on surrounding bone (DeTolla *et al.*, 2000). This method is a numerical technique for solving a complex mechanical problem by dividing the problem domain into smaller and simpler domains (elements) (Geng *et al.*, 2001). Distributions of stress and strain are obtained from the solution of equilibrium equations together with applied loads and constrain conditions (An and Draughn, 1999).

The purpose of this study was to evaluate, by FEM, the influence of mini-screw implant sizes and orthodontic loading forces on stress distribution in miniscrew implant and surrounding bone.

The stress distribution patterns of miniscrew implant models showed that the cervical portion, from the first to the third thread was a weak point of the body. Increases in diameter of miniscrew implant models improved the biomechanical properties of both miniscrew implant and surrounding bone models, whereas increases in length of miniscrew implant models did not significantly improve the biomechanical properties of either miniscrew implant or surrounding bone models. Biomechanically, the recommended size of a miniscrew implant should be 1.6 to 1.8 mm in diameter and more than 4.0 mm in length. Finally, miniscrew implant models of all sizes and surrounding bone models were safe with loading forces of 50 to 400 g.

However, further assessment of stress distribution should be performed to improve the design of miniscrew implants.