

## **CHAPTER III**

### **OBJECTIVE, MATERIAL AND METHOD**

#### **Objective**

To analyze the biomechanical status in term of maximum principle stress (Von Mises Stress) and total displacement of three OMI models on their load transfer by means of a comparative finite element study

#### **Material**

1. Three types of the orthodontic miniscrew implant (OMIs) of 1.6 mm diameter and 6 mm length, including:
  - Type A: **AMI** (ADTEC, Thailand) 1 piece.
  - Type B: **Dual-Top** (Jeil Medical Corp., Korea) (Figure 9) 1 piece.
  - Type C: **Ortho Easy** (Forestadent, Germany) (Figure 10) 1 piece.
2. Video measuring machine [ KIM-CU SERIES No : KIM-CU (Manual Type), Japan ] (Figure 11)
3. Finite element software ( ANSYS V.13)

## 4. Computer

Operating Systems	Windows Vista, XP
RAM	2 GB or more
Disk Space	100 GB or more
Video Card	256 MB (or higher) graphics card (DRD has had good experience with NVIDIA cards).
Processor	Duo Core or Quad Core Processors 2.0 Ghz or faster
Install Media	DVD R/W Drive
Internet Explorer	IE 7,8,9



**Figure 9.** Dual-Top (Jeil Medical Corp., Korea) .



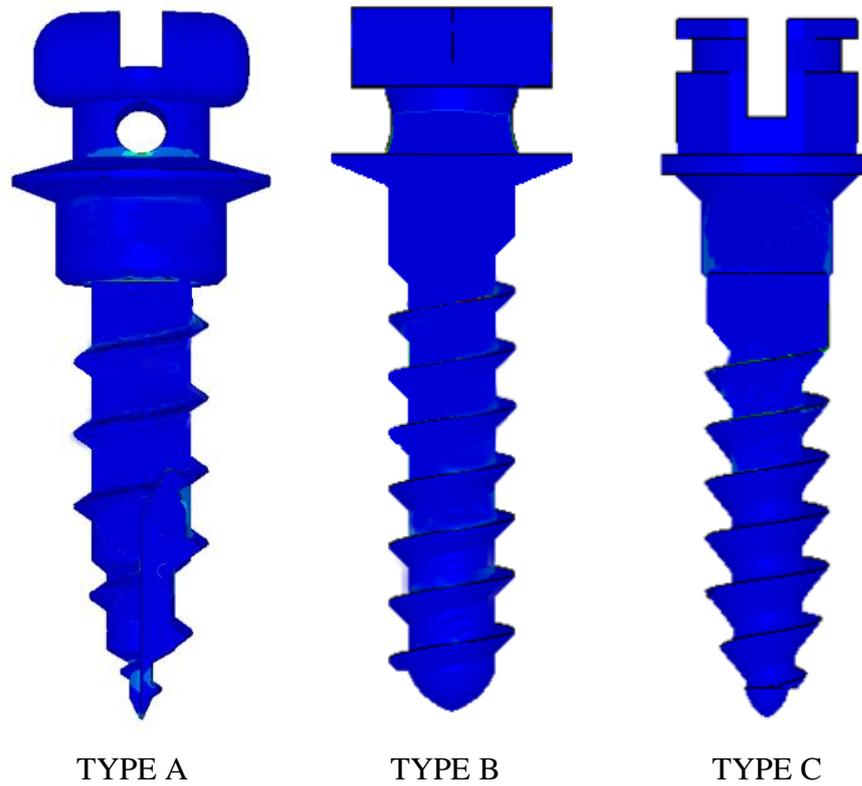
**Figure 10.** Ortho Easy (Forestadent, Germany)



**Figure 11.** Video measuring machine.

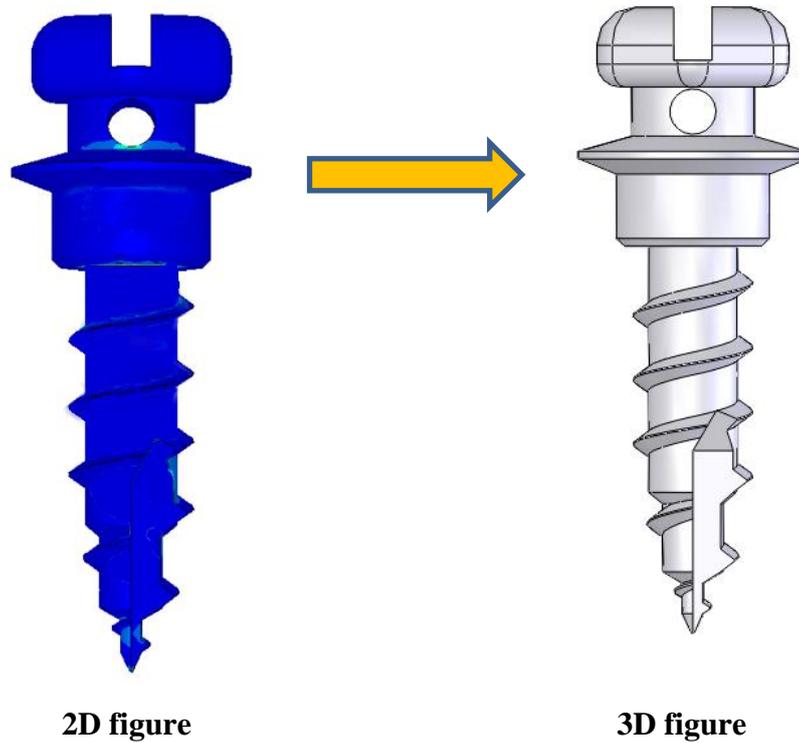
### **Method**

1. Collect three types of the orthodontic miniscrew implant (OMI) samples of 1.6 mm diameter and 6 mm length, and separate them into three groups
  - **GROUP I: Type A, AMI** (ADTEC, Thailand).
  - **GROUP II: Type B, Dual-Top** (Jeil Medical Corp., Korea).
  - **GROUP III: Type C, Ortho Easy** (Forestadent, Germany).
2. Scan three types of OMI and transfer them into two dimension (2D) figures (Figure 12) by using a video measurement scanning technique. This step were repeated twice by different professional experienced-engineers to confirm the pattern of OMI models which absolutely were an identical model. The inter-calibration ( $\kappa$ ) between 2 engineers was more than 0.99.



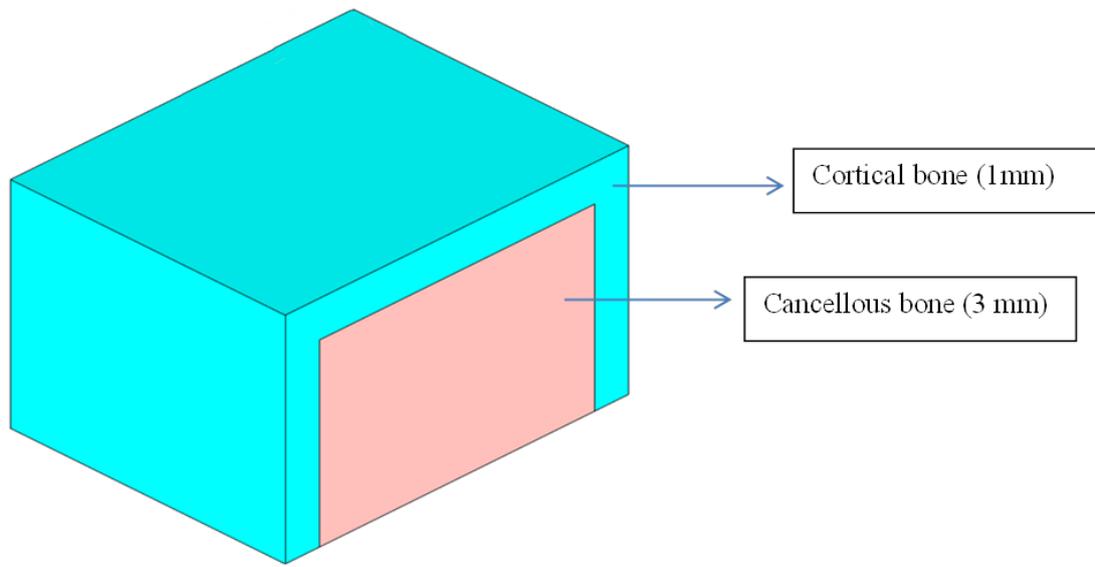
**Figure 12.** The 2D figures of three OMIs.

3. Two dimensions (2D) OMI models were transfer to three dimensions (3D) OMI models (Figure 13) by computer aided design (CAD) technique . Then, all of them were converted to STL files preparing for the loading test.



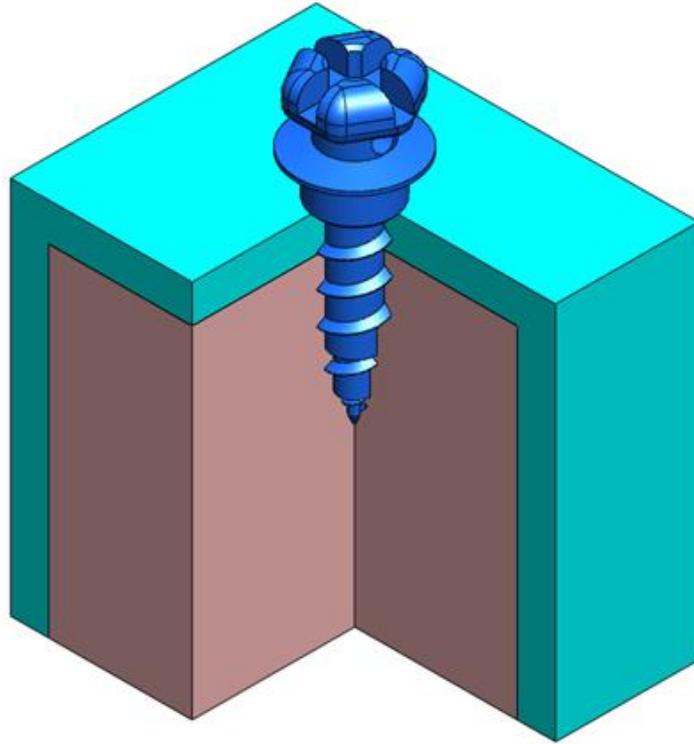
**Figure 13.** Type A OMI (AMI) was transferred from 2D figure to 3D figure by computer aided design (CAD) technique .

4. The bone model were also set up by Computer aided design (CAD) technique imitating the human jaw bone structures which have 1 mm thickness of cortical bone and 3 mm thickness of cancellous bone (Figure 14).

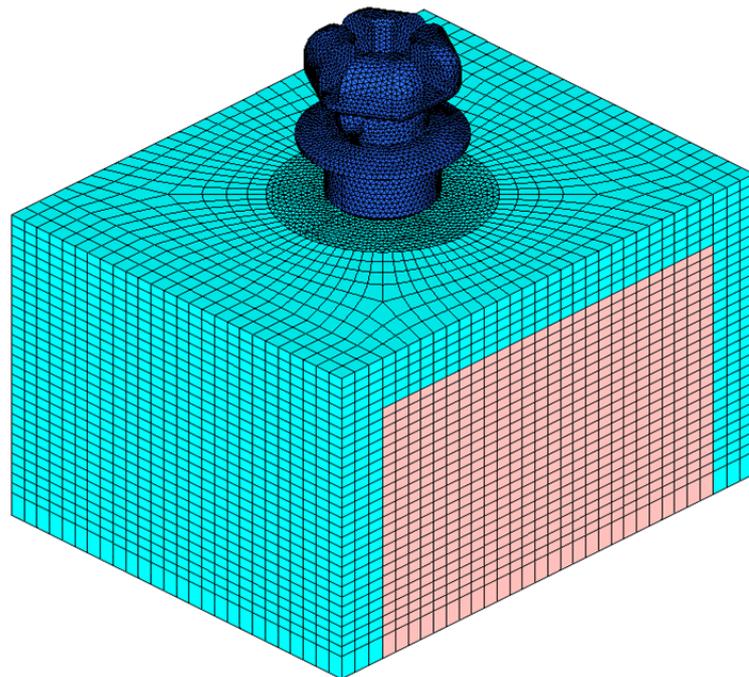


**Figure 14.** The 3-D bone model which consists of 1mm thickness of cortical bone and 3mm thickness of cancellous bone.

5. Set up three types of OMI model by insertion into the bone model (Figure 15) and generated them to be finite element mesh models (Figure 16) preparing for apply the loading forces with finite element software (ANSYS V.13).



**Figure 15.** Three types of OMI model were inserted into the bone model.



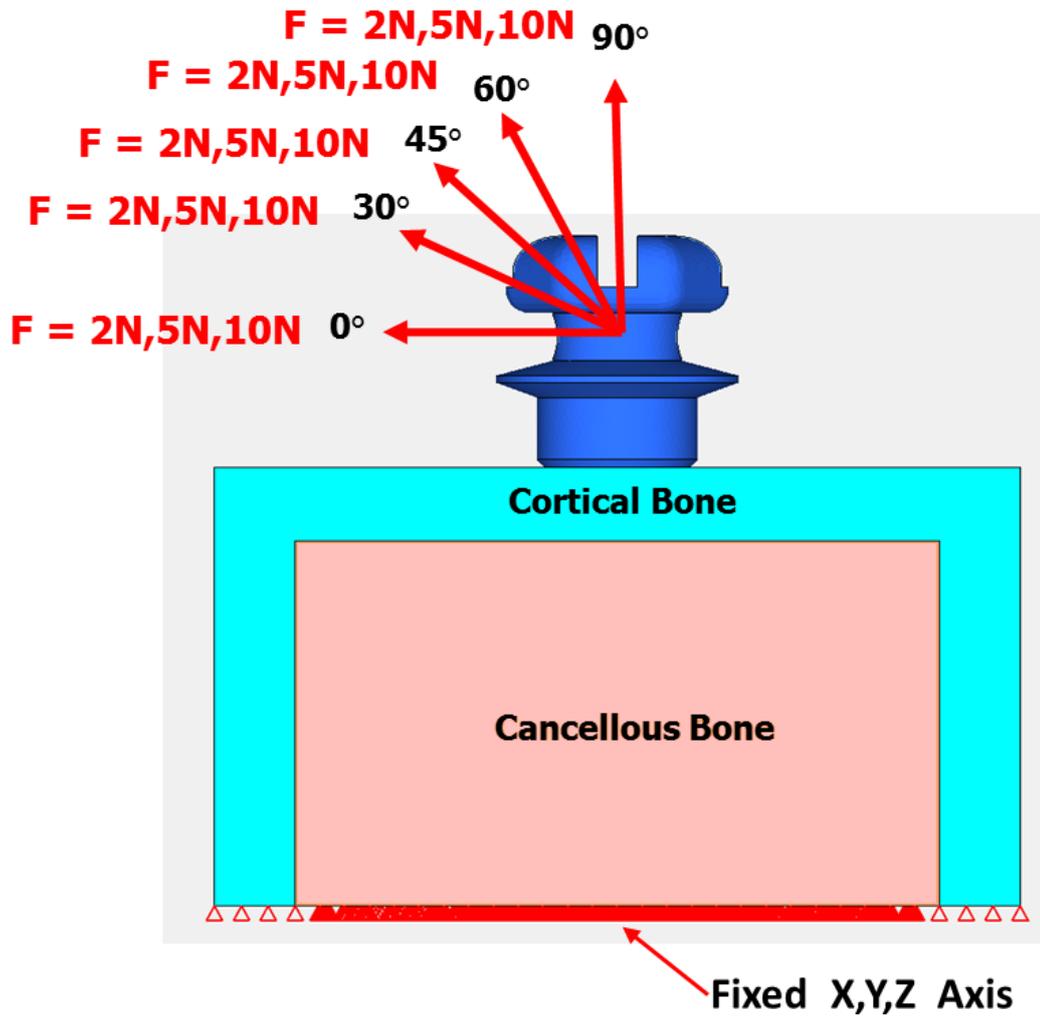
**Figure 16.** Finite element mesh OMI of study model.

6. Indicate the properties of titanium alloy and components of human jaw bone, including cortical and cancellous bone (as described in Table 1), into the FEM program.

**Table 1** The physical properties of titanium alloy and human jaw bone components (cortical bone and cancellous bone) (modified from Lin *et al.*, 2007)

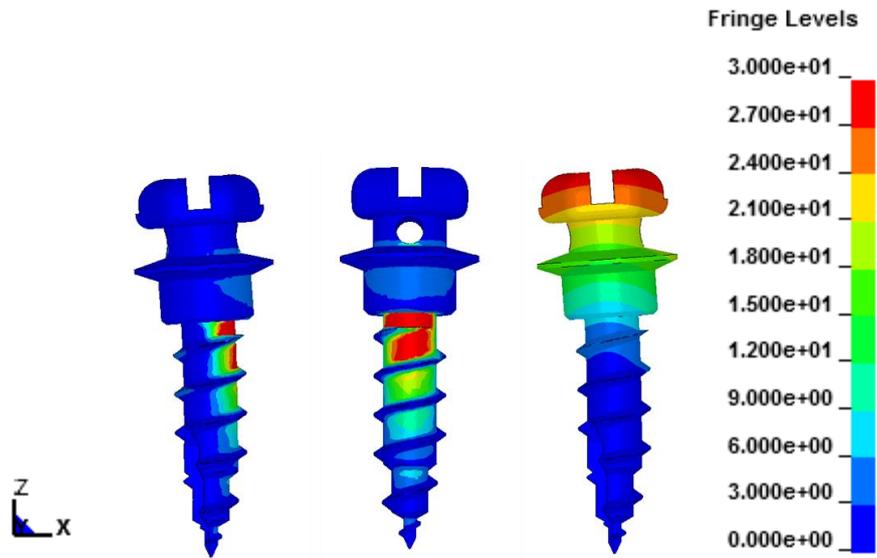
<b>The material properties for using in FEA</b>	<b>Yield strength of titanium (MPa)</b>	<b>Young's modulus (MPa)</b>	<b>Poisson's ratio</b>	<b>Density (<math>\rho</math>) (lb/in<sup>3</sup>)</b>
Cortical bone	114	14,000	0.3	0.16
Cancellous bone	4.8	1,400	0.3	0.16
OMI type A (AMI)	790	110,000	0.35	0.16
OMI type B (Jeil)	790	110,000	0.33	0.16
OMI type C (Forestadent)	790	114,000	0.31	0.16

7. Apply the loading forces of 2, 5, 10 N by parallel to x-axis (0°), y-axis (90°) and oblique 30°, 45°, 60° to x-axis as shown in Figure 17.



**Figure 17.** The OMI models were seated in the bone model and the different loading force (2, 5, 10 N) were at  $0^\circ$ ,  $30^\circ$ ,  $45^\circ$ ,  $60^\circ$ ,  $90^\circ$ .

8. Analyze the maximum principle stress ( Von Mises stress ) and total displacement of three types of OMI model by FEM. Figure 18 showed colors which represent different durable abilities of each type of OMI.



**Figure 18.** Each color showed the stress distribution on each loaded area.

9. Evaluate and Compare the durability of three types of OM I (type A, B, C) in different loading forces descriptively.