CHAPTER III

MATERIALS AND METHODS

Patient Selection

All Thai patients performed MRI of shoulders at Prachacheun Imaging Center between January 2008 – December 2008. The inclusion criteria were age more than 20 years old (skeletal maturation), no any bony destruction on imaging. Congenital and acquired bony deformity, previous shoulder surgery, other inflammatory joint disease were excluded. Eighty-two shoulders that performed MRI were collected and reviewed history and plain radiograph. Eighteen shoulders were excluded as previous shoulder surgery (5), bony deformity (13). Sixty-four shoulders were classified in age , gender and side. Demographic data is shown in Table 1.

Table 1. Demographic Data

Demographic Data	Statistical Data
No. of shoulders , patient	64 , 58
Age (average , yr)	47.266 ± 9.41
Age (min-max , median)	24-60 , 48.5
Weight (average , kg)	62.695 ± 10.92
Height (average , cm)	163.344 ± 7.72
Gender , Age (male / female)	27 / 37 , 45.85 / 48.30
Gender , Weight (male / female)	27 / 37 , 69.11 / 59.01
Gender , Height (male / female)	27 / 37 , 168.78 / 159.38
Side , Age (rt / lt)	33 / 31 , 47.56 / 46.97
No. of patient Age 21 – 40 , average age	11 , 30.455 ± 9.95
No. of patient Age 41 – 60 , average age	53 , 50.755 ± 9.41

MRI Measurements

The patient was performed by using MRI SIEMENS machine (Avanto version VB15 18 channels, Germany) , magnetic field 1.5 Tesla whole body MR Imaging system with an extremity coil. Pulse sequences were T1-weighted images. The position of the arm performed MRI was controlled by epicondylar axis. Coronal view was slice paralleled to this axis and sagittal was perpendicular to this axis. The direction of axial slice imaging placed the slice perpendicular to the humeral shaft axis in the coronal and sagittal plane. All images were reconstructed at 1.5mm slice thickness. Image parameter use 3D Flash, FOV (Field of View) 17x17 cm., matrix 512x512 pixels, coronal oblique plane flip angle 50 degree, coil shoulder array TR/TE = 30/5.6. All images were collected in DICOM files to reconstruct in three dimensions.

3D Image Reconstruction

MRI Data were reconstructed in 3D with Materialize version 11.11 (Mimic). After imported images in three views (coronal , sagittal and coronal oblique), dynamic region growing and multiple slices edit were performed to fill color in the bone contrast all view of humerus (see Fig. 1). Computer software could calculate 3D precisely and surface reconstruction to 3D model of humerus (Fig. 2). Export file.stl data from Materialize and save in file.igs or file.stp. Convert 3D surface model into 3D crown point (Fig. 3) and section precisely at the margin of cartilage at humeral head (Fig. 4). Crown point humeral shaft was section in proximal part (Fig. 5) and distal part (Fig. 6). All sectioned 3D crown point was saved in file.text and export in file.igs

Fig. 1 Three View of MRI in Materialize and 3D Reconstruction

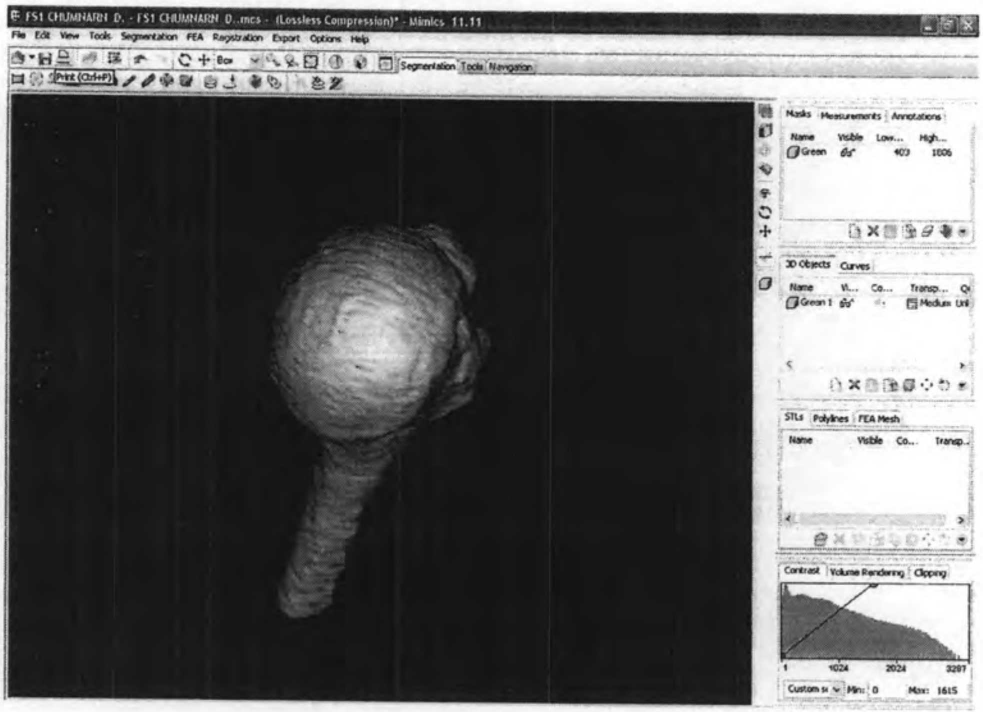

Fig. 2 3D model of proximal humerus after reconstruction in Materialize

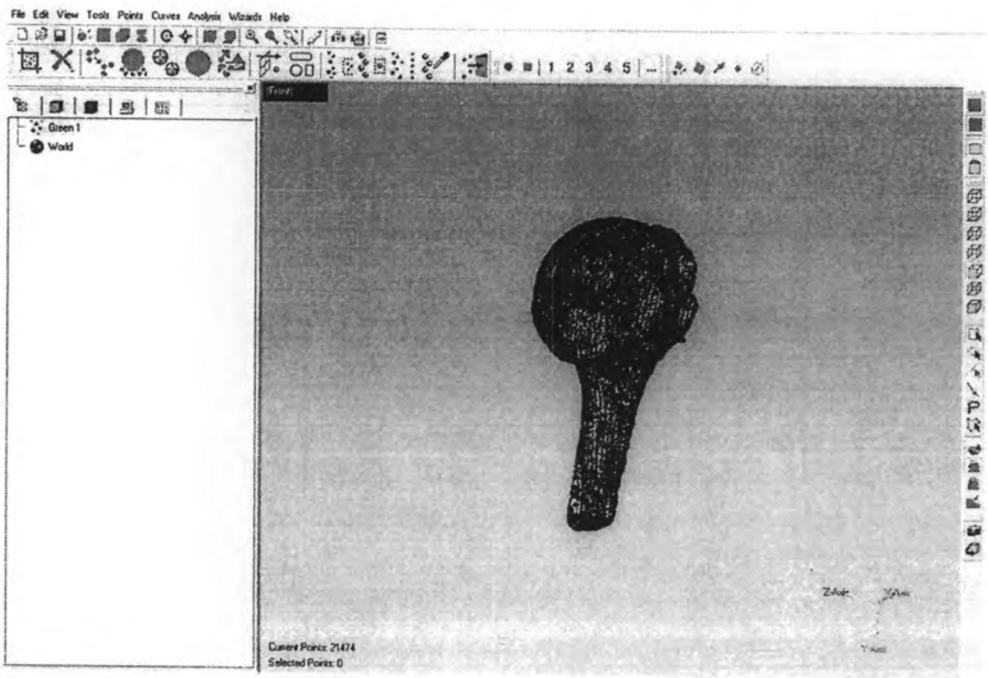

Fig. 3 Surface model coverted to 3D crown point model

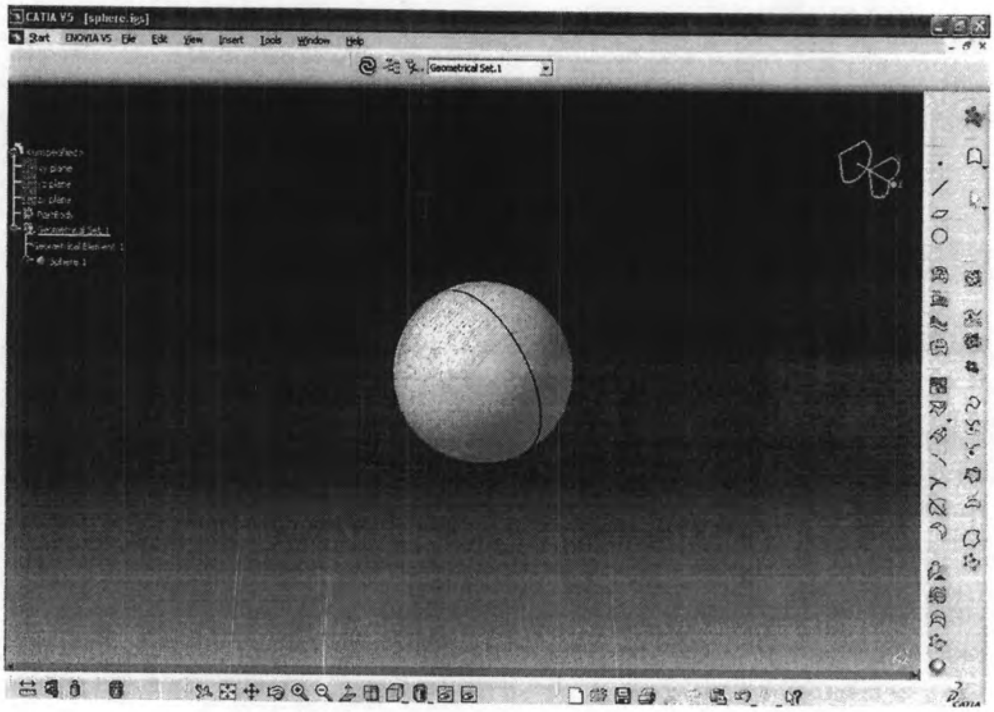

Fig. 4 Resected articular surface of humeral head and computerized calculation the best fitted sphere

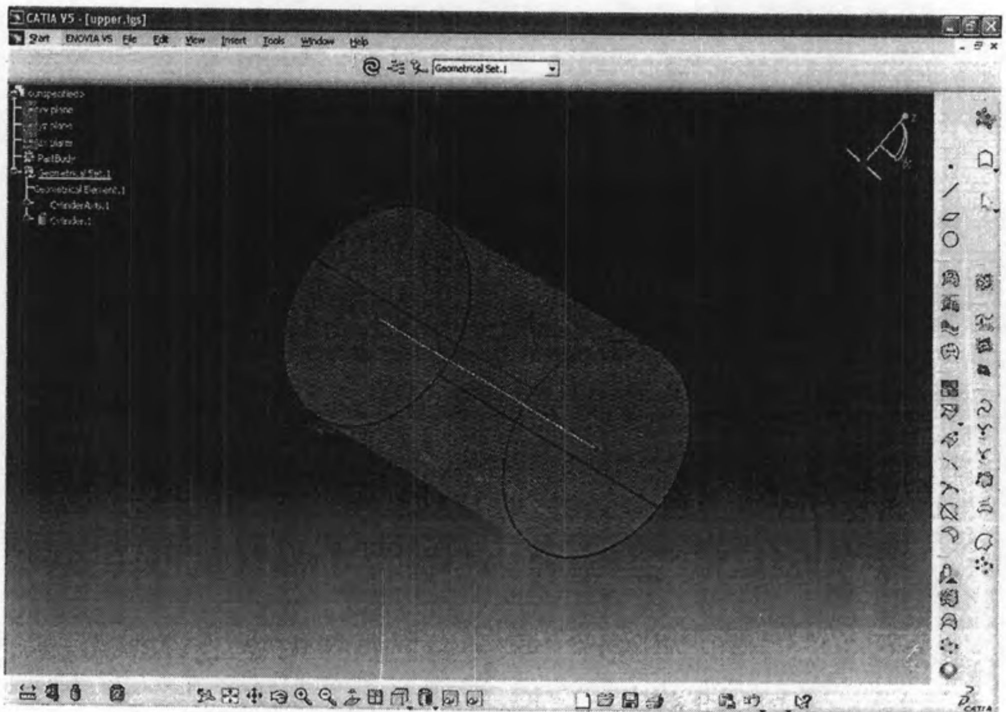

Fig. 5 Resected proximal humerus and computerized calculation the best fitted cylinder, axis of the cylinder.

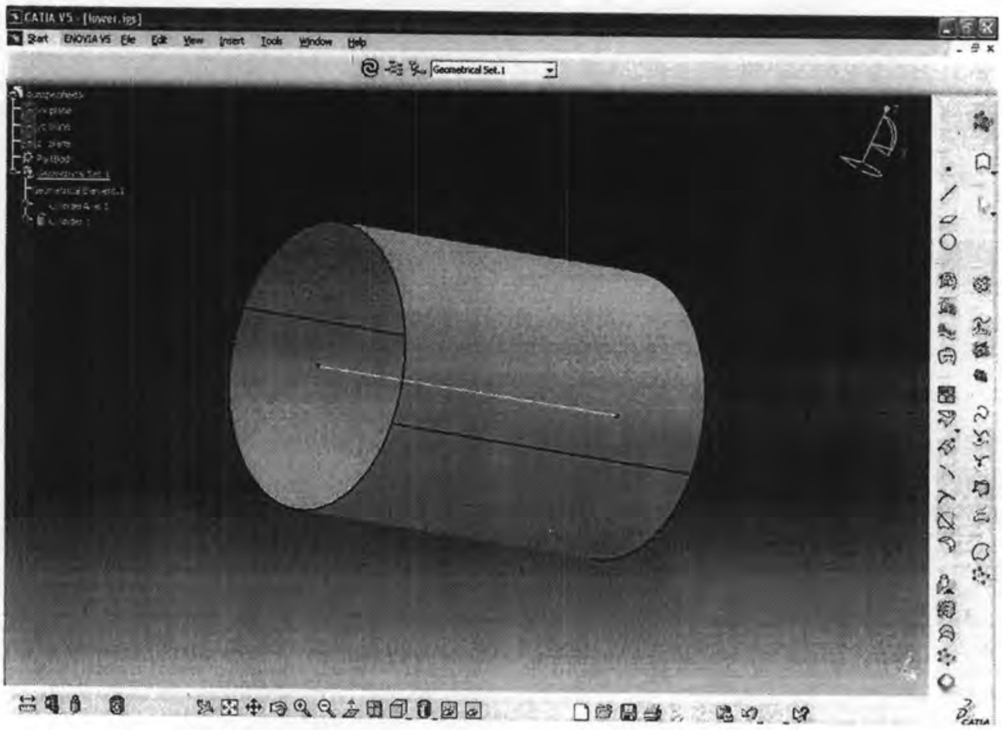

Fig. 6 Resected distal humerus and computerized calculation the best fitted cylinder, axis of the cylinder.

Axis and Plane Identification

Exported data were imported by CATIA version 15 R18 and computerized calculated axis and plane. 3D Crown point was quick surface reconstruction by a computer with the best fitting sphere and best fitting cylinder (Fig. 4-6). Center of sphere and axis of cylinder were calculated and saved the co-ordinate. Join surface reconstruction was performed by wireframe and surface design to solid 3D model (Fig. 7-8). Center and axis were paste on the solid 3D model in the same co-ordinate and we identified as center of humeral head (Fig. 10), axis of proximal humerus and axis of distal humerus. Distal humerus was resected to identified coronal plane from supracondylar ridge that continue from epicondylar eminence. 3 levels of resection and each level had 2 point that continue to supracondylar ridge , identified by the most medial and lateral point after tangency of 2 vertical lines to the medial and lateral side of distal humerus. Coronal plane was reconstruction by the mean through point function (3 medial, 3 lateral)(Fig. 9). Use coronal plane (Fig. 11) and rotate axis of humeral shaft to vertical line to identified Anteroposterior (AP) view of 3D model of humerus.

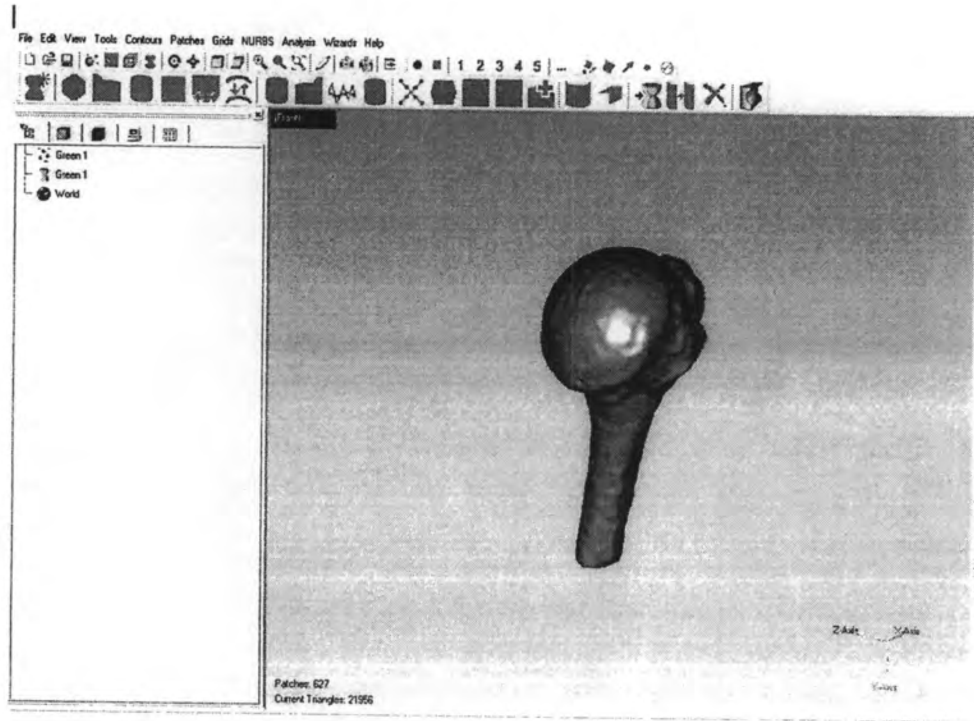

Fig. 7 Join surface reconstruction to create 3D model

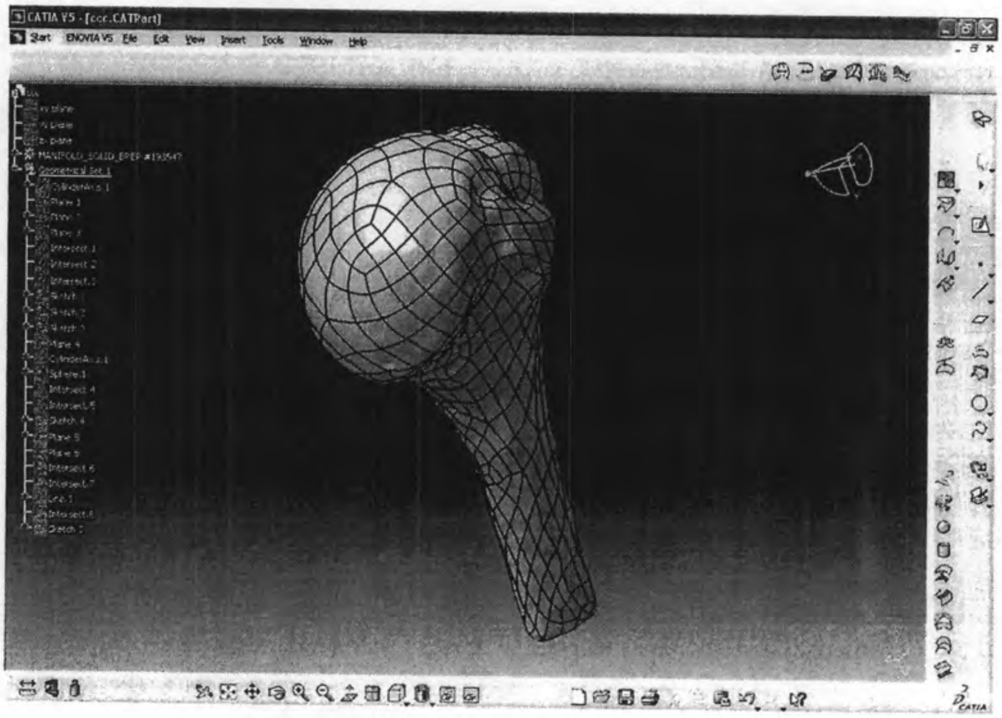

Fig. 8 Wireframe and surface design to create solid 3D image in CATIA

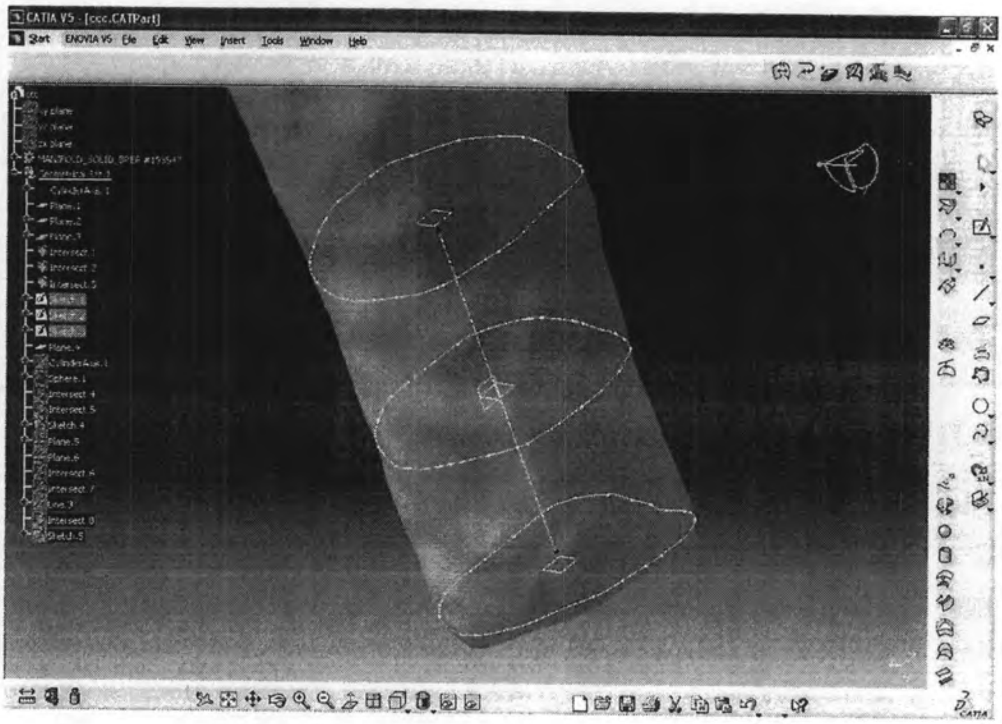

Fig. 9 Identification of coronal plane and the most prominent point then coronal plane created from mean through point function

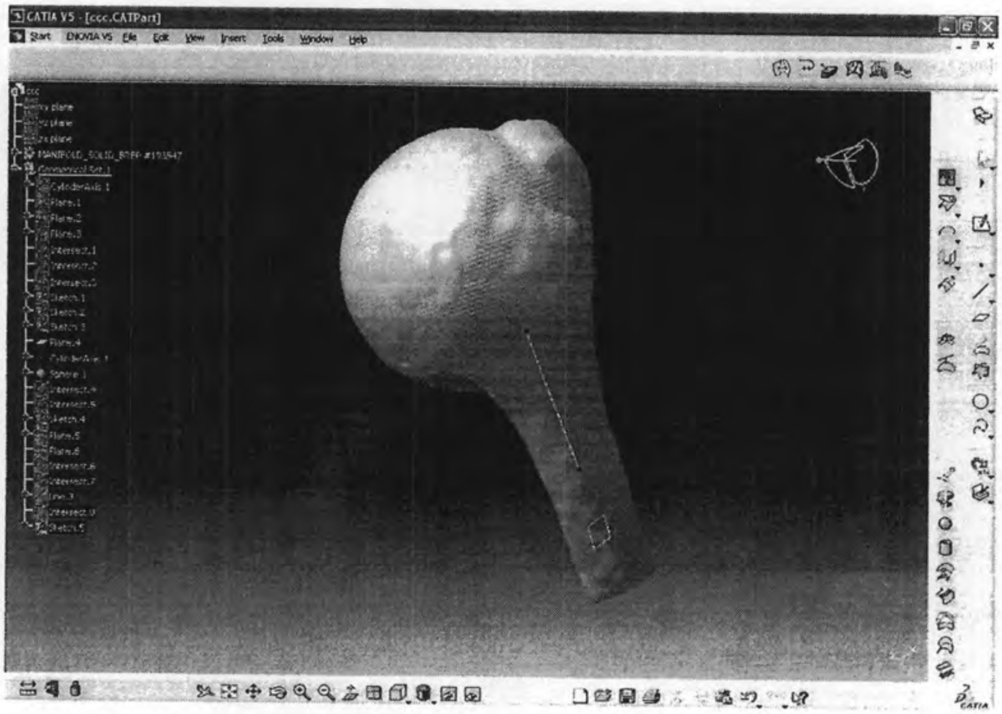

Fig. 10 Best fitted sphere and solid 3D model at the same co-ordination

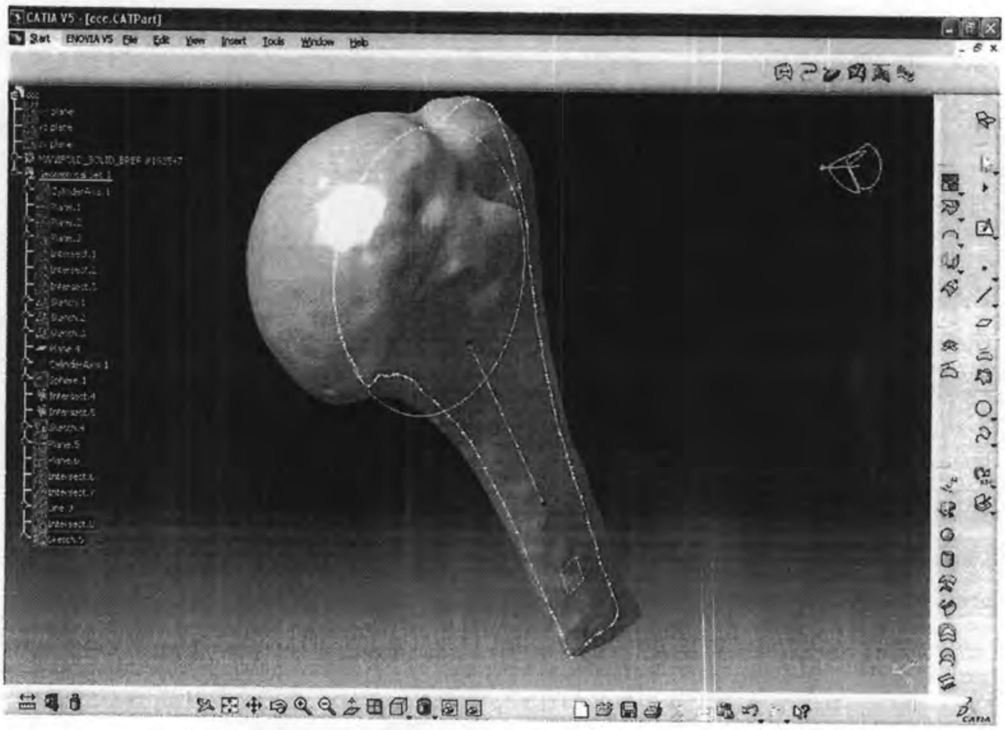

Fig. 11 Coronal plane and proximal humeral axis

The anatomical neck plane was that best fitting the periphery of cartilage in AP view and axial view, identified by the point abrupt change in curvature at the humeral head.

The epiphyseal sphere was computerized calculation best fitted with articular surface of humeral head, and center of the sphere was calculated as center of humeral head.

The proximal humeral cylinder was the cylinder which the best fitted with the proximal shaft of humerus. Defined point is a change in curvature down to humeral shaft. Axis of proximal shaft of humerus was calculated.

The humeral head axis was defined as the line perpendicular to the anatomical neck plane to the apex of articular surface in both axial and AP view.

Apex of articular surface identified by the most prominence point after tangency the line to the articular surface in both axial and coronal view.

The diaphyseal humeral axis was defined as the axis of midshaft and distal of humerus, use in resection perpendicular to this axis to identified coronal plane.

The proximal humeral shaft axis is axis of proximal cylinder of humerus. It represents axis of stem of prosthesis and use in defined neck shaft angle, mediolateral offset, Anteroposterior (AP) offset.

The coronal plane defined by medial and lateral epicondylar ridge and the vertical humeral shaft axis to identified AP view of humeral model.

The axial plane defined as plane perpendicular to coronal plane and humeral shaft axis, computer calculated by rotation X-axis and 90 degree angle to coronal axis (Fig. 12).

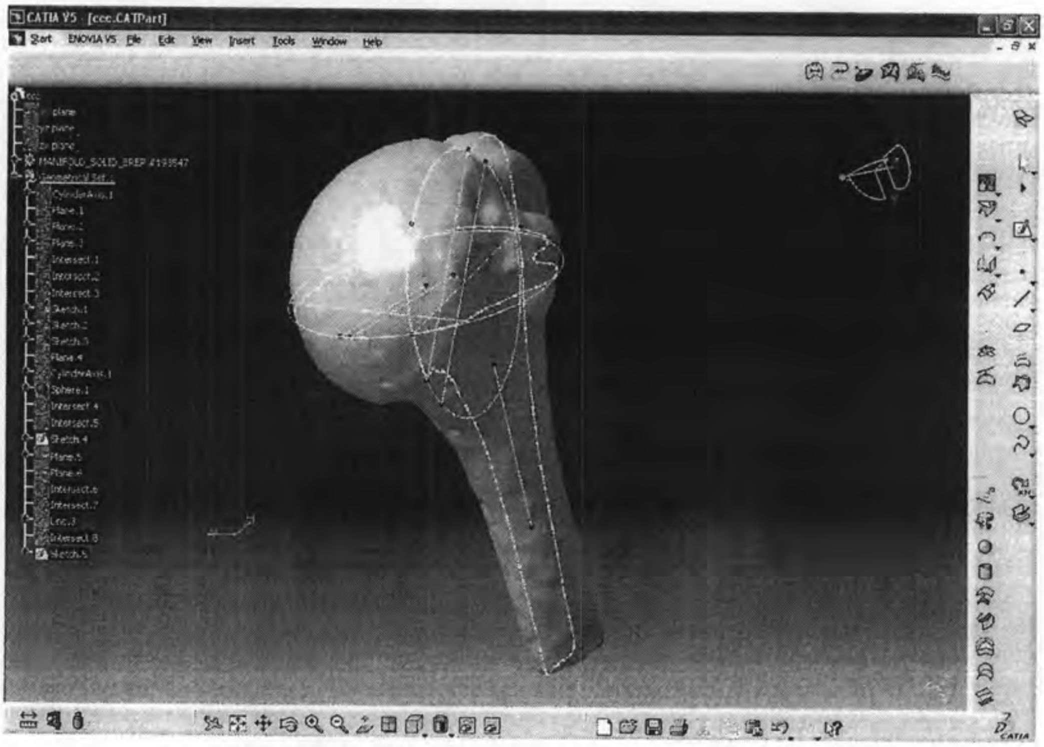

Fig. 12 Planes and axis of proximal humerus

Measured Parameter

The important anatomical humeral parameters were measured By CATIA version 15R18 (length in mm., angle in degree). Data were recorded individually (Fig. 13-14).

1) The diameter of humeral head , diameter of curvature defined as diameter of sphere that best fitted the curvature in both coronal and axial planes.
2) The diameter of articular surface in both coronal and axial plane, defined as the diameter of the articular surface at the level of the margin of the articular cartilage (anatomical neck plane). Level of measured diameter as a level of osteotomy site when performed shoulder arthroplasty.

3) The humeral head thickness, distance perpendicular from anatomical neck plane to the apex of the articular surface.
4) The neck-shaft angle, angle between humeral head axis and the proximal humeral axis.
5) The medial offset defined as perpendicular distance between the center of epiphyseal sphere and the central axis of proximal humeral axis.
6) The retroversion angle, angle between humeral head axis in axial view and coronal plane axis (referred to transepicondylar axis).
7) The posterior offset which is the perpendicular distance between the center of epiphyseal sphere in axial view and the central of proximal humeral axis in axial view.

Fig. 13 Measurement parameters in coronal plane

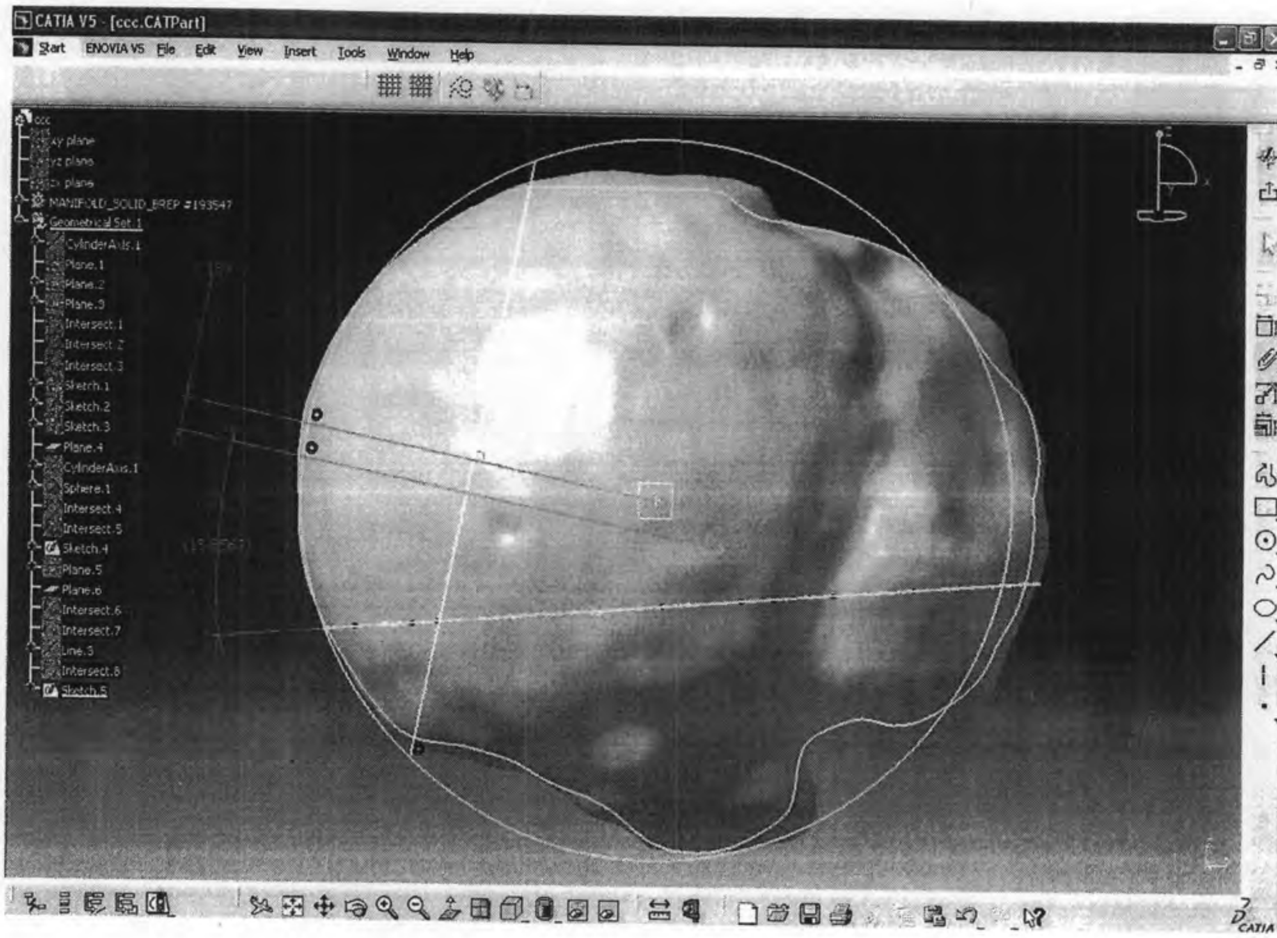

Fig. 14 Measurement parameters in axial plane

To maximized accuracy of this study, we used computerized calculation to reconstruction model, plane, point and all measured parameter. We wanted to reduce human error in every process of the study. Even if the humeral shaft is not true cylinder and humeral head is not true sphere, its axis and theoretical stem and center can be defined. All parameters are summarized as mean and standard deviation (sd). Dimensions of the humerus are compared to the dimensions of the shoulder prosthesis with two systems that available to use in Thailand. Prosthesis consisted of Bigliani (Zimmer ,Warsaw ,Indiana) and Global (Johnson and Johnson). Prosthesis data regarding the size of theses component supplied by distributor companies

Statistic Analysis

All measurement parameters were recorded in millimeters and used mean ± standard deviation to represent result of this study. Results were analyzed between age group, gender and side. Statistical analysis of parameter was two-tailed student t-test and p value option. We identified type I error as 0.05 and type II error as 0.2. A p value < 0.05 indicated a significant difference. Regression analysis determined the correlation between two parameters of proximal humerus and prosthesis systems. Correlation co-efficiency analyzed to determine the correlation among prosthesis and gender. All statistical analysis was performed by SPSS for window version 13.0 and STATA version 10.0.