

CHAPTER IV



RESULTS

The Proximal Humerus Structure

The results of measurement were classified in total group and subgroup analysis by gender, side and age group. The diameter of curvature (diameter of best fitted sphere) varied from a minimum of 28.6 mm. to a maximum of 46.32 mm.. The mean and standard deviation of diameter of sphere were 37.43 ± 4.40 mm. and in male, female were 41.66 ± 2.63 mm., 34.33 ± 2.38 mm. respectively. The mean and standard deviation of diameter of articular surface were 36.64 ± 4.44 mm. and in male was 40.83 ± 2.36 mm., in female was 33.57 ± 2.76 mm. that minimal less than the curvature. Depth of the articular surface (humeral head thickness) was 15.48 ± 2.48 mm.. Depth of male was 16.83 ± 2.05 mm. and in female was 14.50 ± 2.13 mm. (Table 2.). When we analysed diameter of articular surface and articular thickness, linear correlation and regression analysis can be determined. The equation of regression analysis was $y = 0.335x + 2.450$ that x was diameter of articular surface and y was articular thickness (Fig. 16). When we considered about gender, the diameter of both sphere and articular and articular surface thickness in male were larger than female (Fig. 15,17). The difference in these three parameters were significant ($p < 0.0001$) (Table 4.). On the other hand, when we considered about the difference of side (right and left) (Table 5.) and age group (21-40 years old and 40-60 years old) (Table 6.), these three parameters were not different among the groups ($p > 0.05$). So, gender was very important factor but side and age group were not significant factors of diameter and articular thickness of proximal humerus. The results of this study compared to the previous study by Boileau P. et al.(Table 7.), we found the significant difference in diameter of sphere, diameter of articular surface but no statistical difference in articular thickness. Therefore, the result of this study supported the hypothesis that diameter of humeral head in Thai population were smaller than in previous study (Western population).

Table 2. Diameter of sphere and articular surface and articular thickness (mm.)

	Diameter of sphere (mm.)	Diameter of articular surface (mm.)	Articular thickness (mm.)
Total	37.43±4.40 (28.46-46.32)	36.64±4.44 (24.24-45.43)	15.48±2.38 (8.75-20.22)
Male	41.66±2.63 (36.80-46.32)	40.83±2.36 (36.60-45.43)	16.83±2.05 (11.92-20.22)
Female	34.33±2.38 (28.46-39.71)	33.57±2.76 (24.24-39.69)	14.50±2.13 (8.75-19.21)
Right side	38.05±4.26 (28.46-46.32)	37.16±4.40 (24.24-45.43)	15.73±2.27 (11.24-20.21)
Left side	36.76±4.52 (30.54-44.92)	36.08±4.48 (28.81-44.00)	15.22±2.51 (8.75-20.06)
Age 21-40	39.39±4.87 (32.35-46.16)	38.72±4.81 (31.35-44.00)	16.56±2.89 (13.32-20.08)
Age 40-60	37.02±4.25 (28.46-46.32)	36.20±4.28 (24.24-45.43)	15.26±2.20 (8.75-20.22)

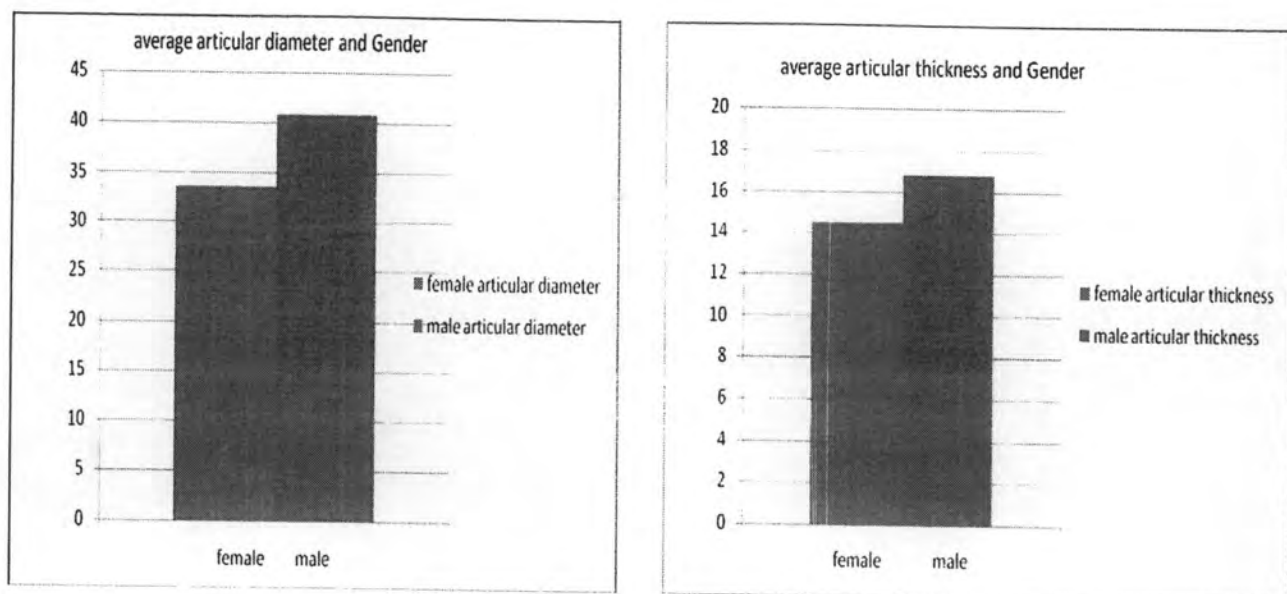


Fig. 15 Graph demonstrating comparison of diameter and thickness of articular between males and females

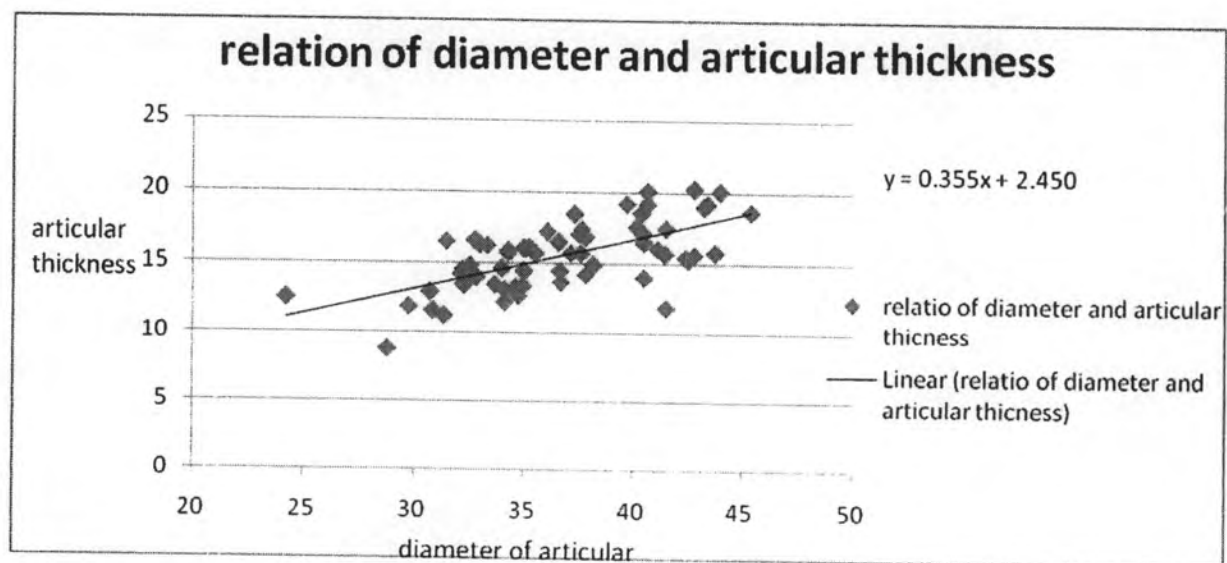


Fig. 16 Graph demonstrating relation of diameter and articular thickness

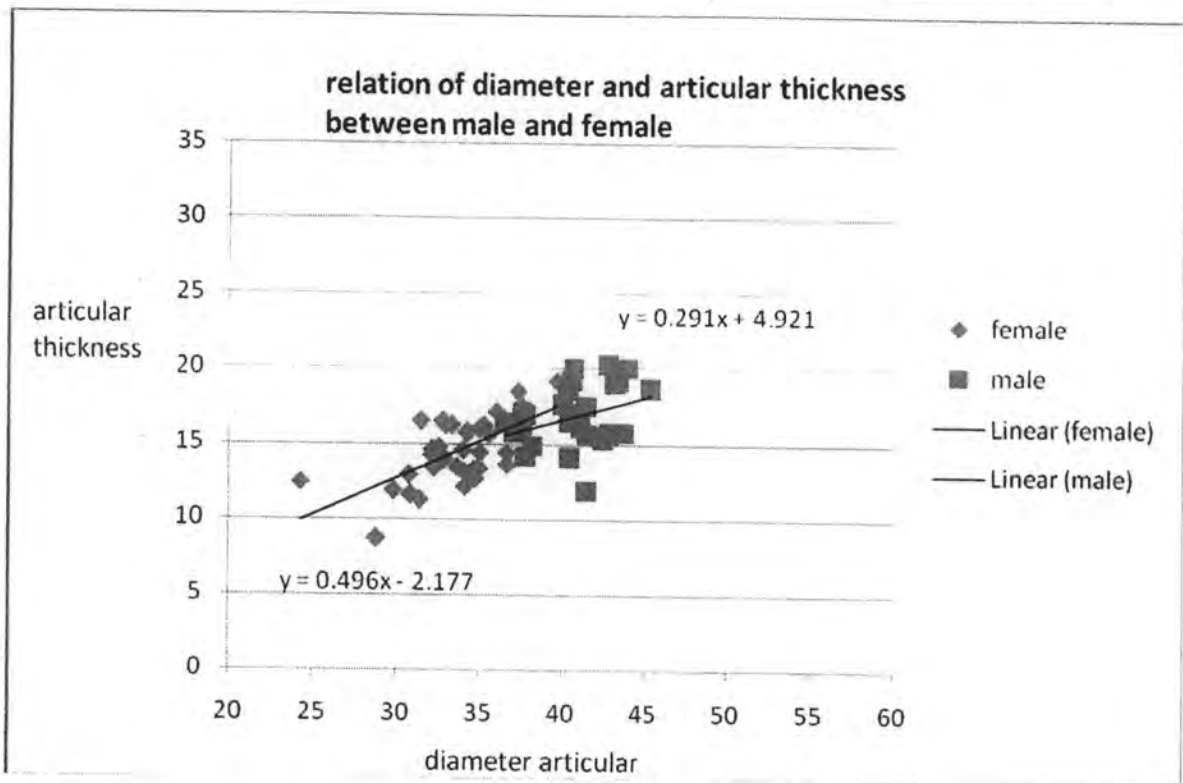


Fig. 17 Graph demonstrating relation of diameter and articular thickness between males and females

The neck-shaft angle with respect to the proximal metaphysic axis had minimum of 110.89 degree to maximum of 151.45 degree. The mean and standard deviation of neck-shaft angle were 137.71 ± 6.43 degree. We founded no difference of this angle among the gender (Fig. 18), side, age group ($p > 0.05$). The mean and standard deviation of medial offset was 5.43 ± 1.51 mm.. We also founded no difference of medial offset among the gender (Fig. 19), side and age group ($p > 0.05$). About the posterior offset, we founded offset range from anterior offset 2.23 mm. to posterior offset 3.02 mm.. Two patients had anterior offset (-2.23 mm., -0.62 mm.) and both of them had retroversion. We can imply that no relation between anterior offset and anteversion or retroversion. The retroversion angle, with respect to the coronal plane, this study had range from anteversion 25.42 degree to retroversion 52.43 degree. The mean and standard deviation of retroversion angle was 13.99 ± 16.17 degree. The result showed high standard deviation of this parameter and had wide range of the angle (Fig. 20). The retroversion angle had high individual difference that can not use some degree of angle as reference to all patients. Nine patients of sixty-four patients (14.06%) had anteversion angle. The difference of these four parameters (neck-shaft angle, medial offset, posterior offset and retroversion

angle) among the gender, side and age group of this study were not significant ($p > 0.05$) (Table 4-6.). Therefore, gender, side and age group were not important factors of these four parameters in proximal humeral prosthesis selection. When compared result of this study to previous study Boileau P. et al.(Table 7.), the neck-shaft angle was significant difference, the medial offset was significant difference, the posterior offset was significant difference and the retroversion angle was not statistical difference. This study supported the difference among the western and Thai population

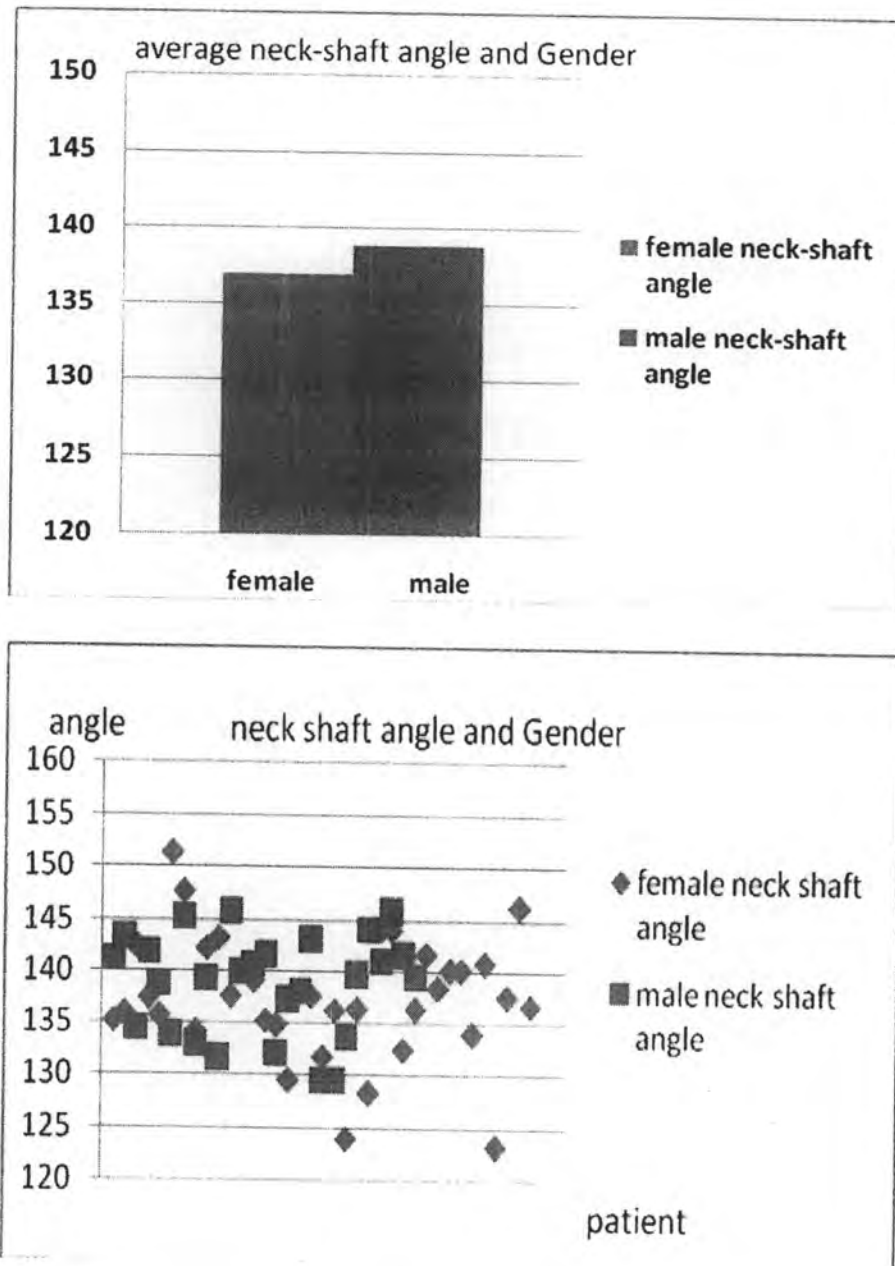


Fig. 18 Graph demonstrating comparison of neck-shaft angle between gender

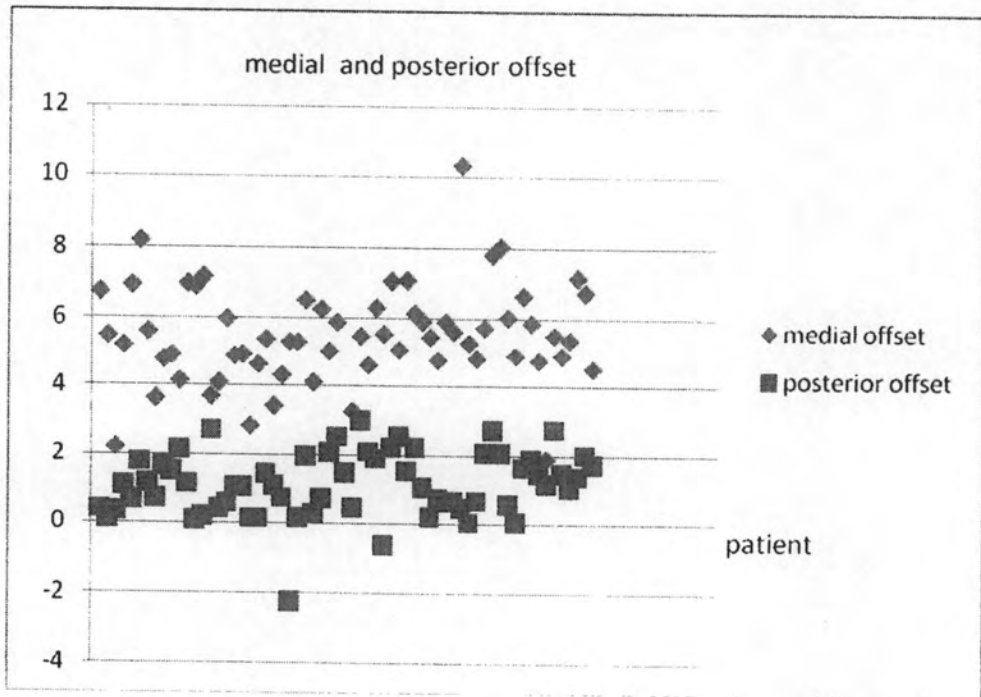
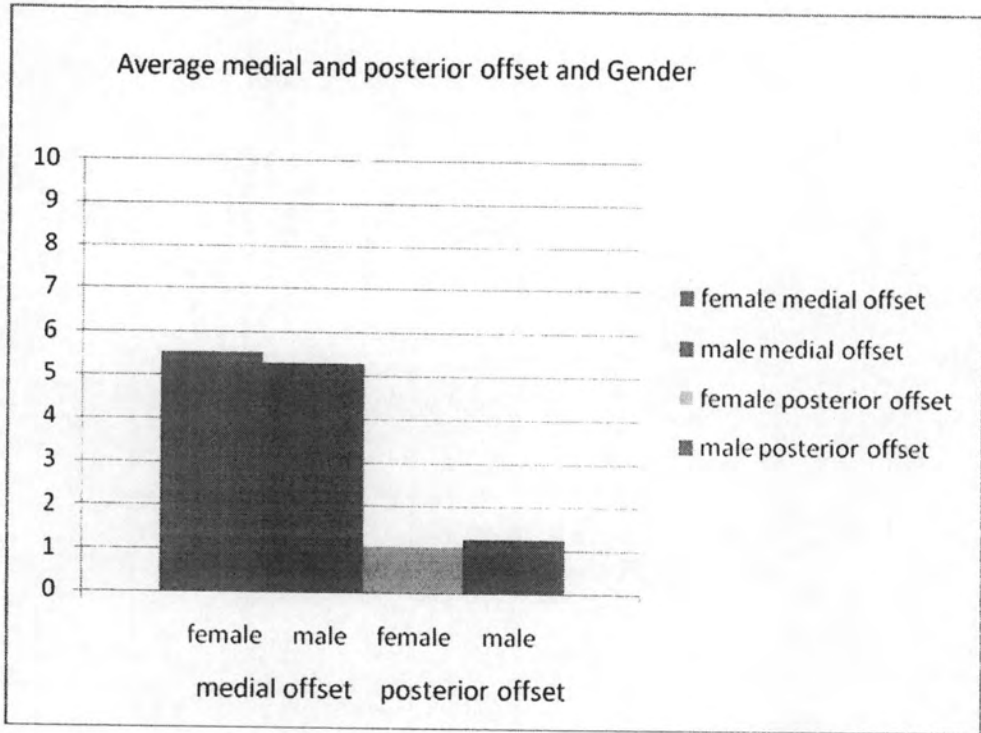


Fig. 19 Graph demonstrating comparison of medial and posterior offset between gender

Table 3. Neck-shaft angle , medial offset, posterior offset and retroversion angle

	Neck-shaft angle	Medial offset	Posterior offset	Retroversion angle
Total	137.71±6.43 (110.89-151.45)	5.43±1.51 (1.49-10.32)	1.15±0.94 (-2.23-3.02)	13.99±16.17 (-25.42-52.43)
Male	138.80±4.86 (129.71-145.92)	5.29±1.81 (1.49-10.36)	1.27±0.80 (0.04-2.76)	10.21±16.16 (-25.42-44.51)
Female	136.92±7.32 (110.89-151.45)	5.53±1.26 (2.84-8.18)	1.06±1.04 (-2.23-3.02)	16.76±15.82 (-11.51-52.43)
Right side	137.72±5.43 (124.08-147.75)	5.49±1.65 (1.88-10.32)	1.29±0.80 (0.15-2.76)	15.82±16.10 (-12.06-52.43)
Left side	137.70±7.44 (110.89-151.45)	5.36±1.37 (1.49-7.82)	1.00±1.07 (-2.23-3.02)	12.05±16.27 (-25.42-48.14)
Age 21-40	136.72±4.81 (128.40-143.12)	6.17±1.36 (3.69-8.18)	1.39±1.01 (0.04-3.02)	8.92±12.79 (-14.90-24.17)
Age 40-60	137.92±6.80 (110.89-151.45)	5.27±1.52 (1.49-10.32)	1.10±0.94 (-2.23-2.76)	15.05±15.86 (-12.06-52.43)

Table 4. Comparison parameters between genders

	Female	Male	P value
Diameter of sphere	34.33±2.38 (28.46-39.71)	41.66±2.63 (36.80-46.32)	P<0.0001
Diameter of articular	33.57±2.76 (24.24-39.69)	40.83±2.36 (36.60-45.43)	P<0.0001
Articular thickness	14.50±2.13 (8.75-19.21)	16.83±2.05 (11.92-20.22)	P<0.0001
Femoral neck-shaft angle	136.92±7.32 (110.89-151.45)	138.80±4.86 (129.71-145.92)	0.249
Medial offset	5.53±1.26 (2.84-8.18)	5.29±1.81 (1.49-10.36)	0.539
Posterior offset	1.06±1.04 (-2.23-3.02)	1.27±0.80 (0.04-2.76)	0.388
Retroversion angle	16.76±15.82 (-11.51-52.43)	10.21±16.16 (-25.42-44.51)	0.111

Table 5. Comparison parameters between sides

	Right side	Left side	P value
Diameter of sphere	38.05±4.26 (28.46-46.32)	36.76±4.52 (30.54-44.92)	0.246
Diameter of articular	37.16±4.40 (24.24-45.43)	36.08±4.48 (28.81-44.00)	0.336
Articular thickness	15.73±2.27 (11.24-20.21)	15.22±2.51 (8.75-20.06)	0.397
Femoral neck-shaft angle	137.72±5.43 (124.08-147.75)	137.70±7.44 (110.89-151.45)	0.991
Medial offset	5.49±1.65 (1.88-10.32)	5.36±1.37 (1.49-7.82)	0.749
Posterior offset	1.29±0.80 (0.15-2.76)	1.00±1.07 (-2.23-3.02)	0.222
Retroversion angle	15.82±16.10 (-12.06-52.43)	12.05±16.27 (-25.42-48.14)	0.355

Table 6. Comparison parameters between age groups

	Age 21-40	Age 40-60	P value
Diameter of sphere	39.39±4.87 (32.35-46.16)	37.02±4.25 (28.46-46.32)	0.097
Diameter of articular	38.72±4.81 (31.35-44.00)	36.20±4.28 (24.24-45.43)	0.078
Articular thickness	16.56±2.89 (13.32-20.08)	15.26±2.20 (8.75-20.22)	0.084
Femoral neck-shaft angle	136.72±4.81 (128.40-143.12)	137.92±6.80 (110.89-151.45)	0.590
Medial offset	6.17±1.36 (3.69-8.18)	5.27±1.52 (1.49-10.32)	0.115
Posterior offset	1.39±1.01 (0.04-3.02)	1.10±0.94 (-2.23-2.76)	0.341
Retroversion angle	8.92±12.79 (-14.90-24.17)	15.05±15.86 (-12.06-52.43)	0.182

Table 7. Comparison parameters between this study and previous study^[2]

	This study	Boileau P. et al.	P Value
Diameter of sphere	37.43±4.40 (28.46-6.32)	46.2±5.4 (37.1-56.9)	P<0.001
Diameter of articular	36.64±4.44 (24.24-45.43)	43.3±4.3 (36.5-51.7)	P<0.001
Articular thickness	15.48±2.38 (8.75-20.22)	15.2±1.6 (12.1-18.2)	0.436
Femoral neck-shaft angle	137.71±6.43 (110.89-151.45)	129.6±2.9 (123.2-135.8)	P< 0.001
Medial offset	5.43±1.51 (1.49-10.32)	6.9±2.0 (2.9-10.8)	P<0.001
Posterior offset	1.15±0.94 (-2.23-3.02)	2.6±1.8 (-0.8-6.1)	P<0.001
Retroversion angle	13.99±16.17 (-25.42-52.43)	17.9±13.7 (-6.7-47.5)	0.143

The proximal humeral prosthesis

In Thailand, we have two prosthesis systems used in shoulder prosthesis. One was Bigliani II^[23] (Zimmer, Warsaw, Indiana) (Fig. 21) and the other was Global (Johnson and Johnson). First we discussed on Zimmer prosthesis. The Zimmer prosthesis had two systems that were standard and expanded head having larger diameter (56 mm.) and more articular thickness (>30 mm.). The range of articular diameter was 40-56 mm. and the articular thickness range was 15-36 mm. as shown in table 8. (Fig. 23). Second system was Global^[24] (Fig. 22) that had range of articular diameter 40-56 mm. and three size of articular thickness (15, 18, 21) as shown in table 9. (Fig. 24). The Zimmer prosthesis had more wide range size of articular thickness than Johnson prosthesis but Johnson prosthesis had more wide range size of articular diameter than Zimmer prosthesis (Fig. 25). When we consider about correlation of diameter and thickness of both system, we founded prosthesis head came in differing thickness but same diameter. This correlation had effect on selection prosthesis on shoulder arthroplasty surgery.



Fig. 21 Zimmer shoulder prosthesis

Table 8. Diameter and thickness of articular in zimmer prosthesis

Articular diameter (mm.)	Articular thickness (mm.)
40	15
40	18
40	21
40	24
40	27
46	15
46	17
46	18
46	19
46	21
46	23
46	24
46	27
46	30
46	33
52	18
52	19
52	21
52	23
52	24
52	27
52	30
52	33
52	36
56	30
56	33
56	36
56	39
56	42



Fig. 22 Johnson and Johnson prosthesis

Table 9. Diameter and thickness of articular in Johnson prosthesis

Articular diameter (mm.)	Articular thickness (mm.)
40	15
40	18
40	21
44	15
44	18
44	21
48	15
48	18
48	21
52	15
52	18
52	21
56	15
56	18
56	21

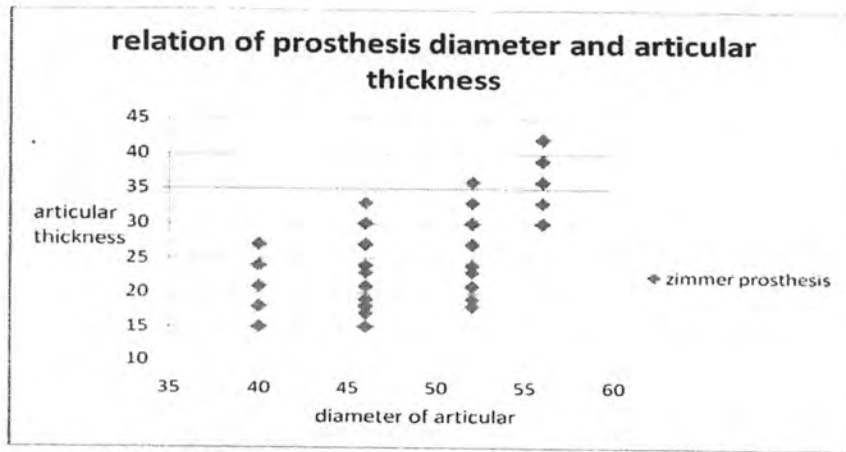


Fig. 23 Graph demonstrating relation of diameter and thickness of articular in Zimmer prosthesis

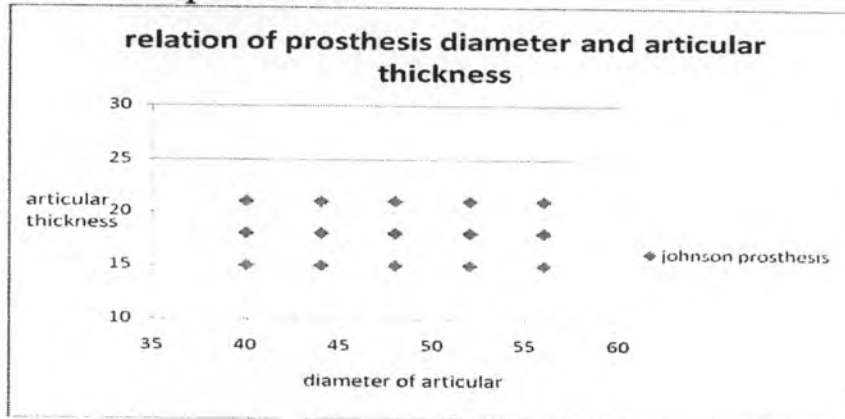


Fig. 24 Graph demonstrating relation of diameter and thickness of articular in Johnson prosthesis

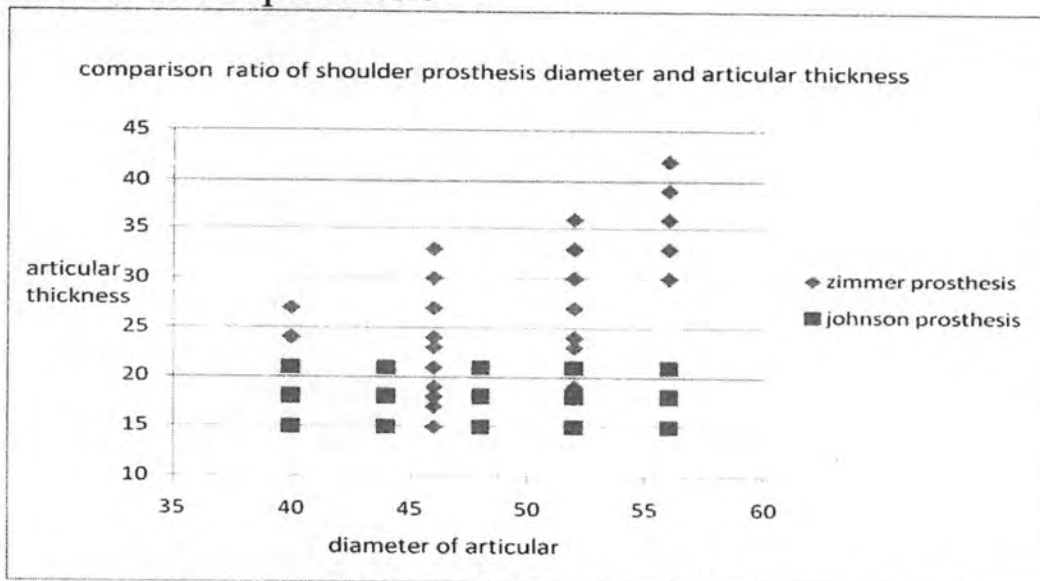


Fig. 25 Graph demonstrating comparison of diameter and thickness of articular between Zimmer and Johnson prosthesis

Comparison of articular diameter and articular thickness in Thai female proximal humerus versus shoulder prostheses

See Fig. 26, the study showed that the range of the diameter of sphere in Thai female was 28.46-39.71 mm., the range of the diameter of articular surface was 24.24-39.69 mm., and that of the articular thickness was 8.75-19.21 mm.. When we compared to both prosthesis that currently used in Thailand, we founded the dimension of Thai female was significant smaller size than prosthesis in both diameter and thickness. The correlation coefficient of female data and Zimmer (see Table 10.) prosthesis was -0.036 for the diameter of sphere, -0.119 for diameter of articular, and -0.137 for the articular thickness. These correlation coefficient and Johnson prosthesis (see Table 11.) was 0.029 for diameter of sphere, 0.076 for diameter of articular and -0.006 for the articular thickness. These statistical data had range from (-1) – 1. Both of the prosthesis systems were not proper to used for Thai female people.

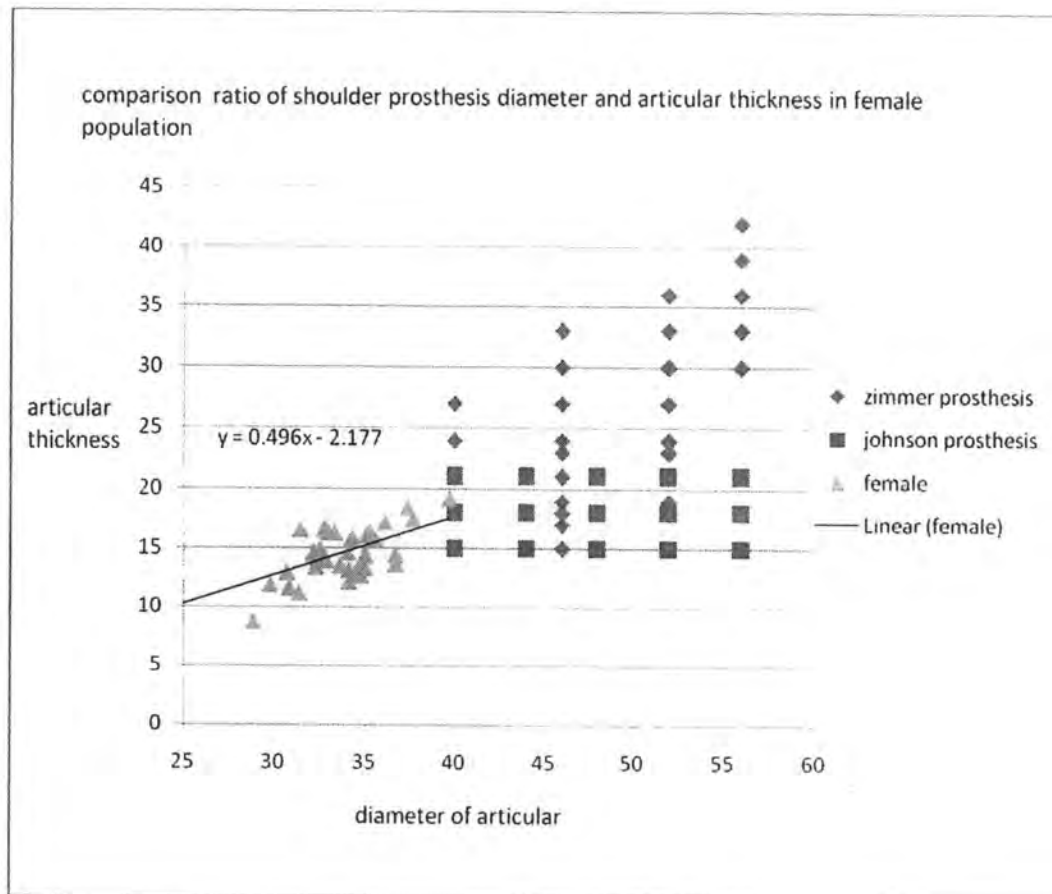


Fig. 26 Graph demonstrating comparison of diameter and thickness of articular between females and both prosthesis

Comparison of articular diameter and articular thickness in Thai male proximal humerus versus shoulder prostheses

See Fig. 27, the study showed that the range of the diameter of sphere in Thai male was 36.80-46.32 mm., the range of the diameter of articular surface was 36.60-45.43 mm. and that of the articular thickness was 11.92-20.22 mm.. When we compared to both prosthesis that currently used in Thailand, we founded the dimension of Thai male was significant smaller size than prosthesis in both diameter and thickness. The correlation coefficient of male data and Zimmer prosthesis (see Table 10.) was -0.157 for the diameter of sphere, -0.062 for diameter of articular, and 0.162 for the articular thickness. These correlation coefficient and Johnson prosthesis (see Table 11.) was -0.144 for diameter of sphere, -0.125 for diameter of articular, and 0.244 for the articular thickness. These statistical data had range from (-1) – 1. Smaller size of both of the prosthesis systems is closer to the some of Thai male humeral geometry. In the smaller group size, Zimmer had the wide range of the articular thickness with the same diameter.

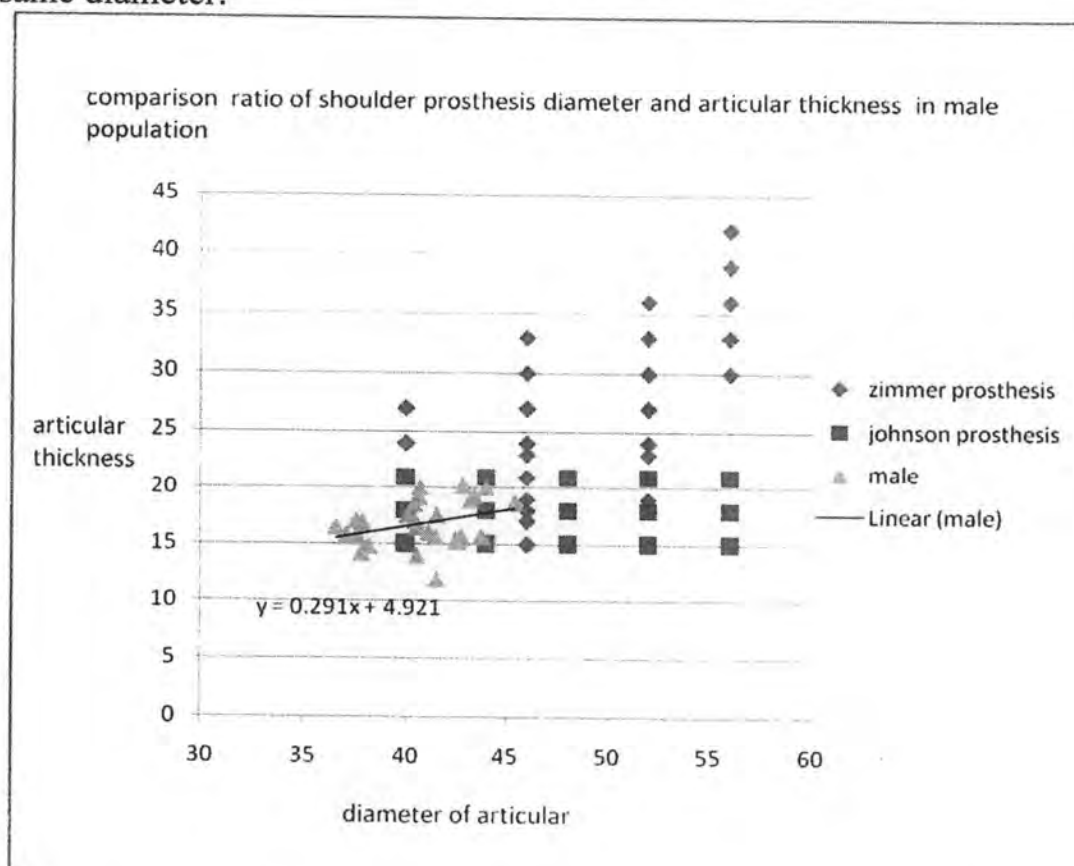


Fig. 27 Graph comparison of diameter and thickness of articular between Thai female and both prosthesis

Table 10. Correlation coefficient between Zimmer prosthesis and gender

Parameters	Female	Male
Diameter of sphere	-0.036	-0.157
Diameter of articular	-0.119	-0.062
Articular thickness	-0.137	0.162

Table 11. Correlation coefficient between Johnson prosthesis and gender

Parameters	Female	Male
Diameter of sphere	0.029	-0.144
Diameter of articular	0.076	-0.125
Articular thickness	-0.006	0.244