A CROSS SECTIONAL STUDY OF THE PROXIMAL FEMUR MORPHOLOGY OF THE NORMAL MALAY POPULATION USING COMPUTED TOMOGRAPHY IMAGES (SCANOGRAM) AT HUSM

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Dissertation Submitted In Partial Fulfillment
Of The Requirements For The Degree Of
Master of Medicine (Orthopaedics)

UNIVERSITI SAINS MALAYSIA

MAY 2008

ACKNOWLEDGEMENT

Specially Dedicated To

My Wife

Normalinda Binti Yaacob

&

My Children

Danial Muhaimin

Nursakinah Sofya

Nurauny Balqis

For Their Patience, Love and Support

ACKNOWLEDGEMENTS

Bismillahirrahmannirrahim

Praise to Allah s.w.t, the Most Compassionate and the Most Merciful. Alhamdulillah, with the strength from Him has enabled me to prepare the dissertation, complete this paper and go through the program of Masters in Orthopaedic in School of Medical Science, Universiti Sains Malaysia, Kelantan.

I would like to express deepest gratitude and thanks to the following individuals for their help, advice, guidance, comments and support during the preparation of this dissertation.

- Dr. Amran B. Ahmed Shokeri supervisor of this study and Lecturer/Surgeon, Department of Orthopaedic, Hospital Universiti Sains Malaysia (HUSM) for his guidance and patience during the course of this study and completion of this paper.

- Dr. Vishvanathan A/L Thimurayan former supervisor of this study and lecturer/surgeon, Department of Orthopaedic, Hospital Universiti Sains Malaysia (HUSM) for his guidance and ideas.

- Mr. Anwar Hau B. Abdullah, Senior Orthopaedic Consultant, Department of Orthopaedic, Hospital Raja Perempuan Zainab 11

(HRPZ 11).

- Dr. Liau Kai Ming, supervisor of this study and Lecturer/Surgeon, Department of Orthopaedic, Hospital Universiti Sains Malaysia (HUSM) for his ideas and guidance.

- Dr. Mohd Ezanee B. Aziz, co-supervisor of this study and Lecturer, Department of Radiology, HUSM for his guidance and support during the course of this study and completion of this paper.

- Dr. Abdul Razak B. Sulaiman, senior orthopaedic lecturer/surgeon for helping me overcoming the ethics committee.

- Dr. Kamarul Imran Musa and Dr. Sarimah Abdullah, Lecturer from Department of Community Medicine, HUSM for helping me overcoming the statistical obstacle and producing the final results of this study.

- Mr. Che Nazri B. Che Hussin, Mr. Sayuti B. Mat Deris and Mr. Nik Fauriza B. Nik Lah, Radiographer from Department of Radiology, HUSM which helped me tremendously in obtaining the data for this study.

- To my parents, Mr. Ismail Jusoh and Madam Haminah Daud, thank you for all your support throughout the years.

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Study Design

A cross sectional study on the morphometry of proximal femur in Malay patients who were treated in Hospital Universiti Sains Malaysia.

Objectives

To quantify the proximal femur dimensions in Malay patients, to compare the parameters between male and female patients and to determine the correlation between the parameters.

Summary of the Background Data

Previous studies have shown a significantly smaller proximal femur parameters in the Asian population compared to Caucasian population. Currently used proximal femur implants size were based on Caucasian studies. However, due to the smaller size of proximal femur in Asian population, improvement in the design of implant are required to optimize component fixation and to restore the normal biomechanics of the hip joint.

Methods

Proximal femoral bones were studied in 140 patients (70 male and 70 female) who had undergone computerized tomographic scan for various pelvic pathology but with normal proximal femur morphology. The age range was between 18 to 80 years old. The

following parameters were studied : 1) Femoral neck shaft angle, 2) Femoral head diameter, 3) Femoral neck isthmus diameter, 4) Vertical offset of femur, 5) Horizontal offset of femur. The data obtained were statistically analyzed using independent T-test to determine the differences between male and female patients. The mean of all the parameters of current study were compared with published Western and Asian studies using one sample T-test. Significant differences for all the statistical test were set at $p < 0.05$.

Results

There were significant differences between male and female patients in femoral head diameter, femoral neck isthmus diameter, vertical offset and horizontal offset. However, there was no significant difference in neck shaft angle. Female patients have significantly smaller dimensions in all the parameters measured except for neck shaft angle which was larger.

When the observations in the current study was compared to radiographic study by Sugano et al and Noble et al, significant differences were found in head diameter, neck isthmus diameter, vertical offset and neck shaft angle. The head diameter , neck isthmus diameter and vertical offset of the current study were significantly smaller compared to their study. However the neck shaft angle of the current study was significantly larger than their study.

Conclusions

The current study have shown that the proximal femur morphometry of Malay population was smaller compared to Caucasion and Thai population.

ABSTRAK

Bentuk Kajian

Kajian " cross sectional " tentang morfometri femur bahagian atas, ke atas pesakit kaum Melayu yang telah menjalani rawatan di Hosptal Universiti Sains Malaysia.

Objektif

Untuk mengkuantifikasikan struktur dan dimensi femur bahagian atas pesakit kaum Melayu dengan memperbandingkan ukuran-ukuran diantara pesakit lelaki dan perempuan beserta kaitan atau hubungan diantara ukuran-ukuran tersebut.

Kesimpulan Data Terdahulu

Banyak kajian terdahulu tentang femur bahagian atas telah dijalankan di kalangan penduduk Asia dan penduduk kaum kulit putih. Kajian-kajian tersebut menunjukan bahawa ukuran femur bahagian atas adalah lebih kecil di kalangan kaum Asia berbanding kaum kulit putih.

Pada masa ini , penggunaan implan femur bahagian atas adalah berdasarkan parameter kaum kulit putih. Walaubagaimanapun, disebabkan femur bahagian atas kaum Asia lebih kecil , pembaikan dalam rekaan diperlukan.

Metodologi

Pengukuran femur bahagian atas telah diperolehi daripada 140 orang pesakit (70 orang lelaki dan 70 orang perempuan) yang telah menjalani " computerized tomographic scan " untuk pelbagai penyakit dalam bahagian tulang pinggul, tetapi femur bahagian atas adalah normal. Usia pesakit adalah dalam lingkungan 18 hingga 80 tahun. Ukuran-ukuran berikut telah dilakukan 1) sudut diantara kepanjangan (shaft) femur dan leher (neck) femur, 2) Diameter kepala femur, 3) Diameter terkecil leher femur, 4) Garis menegak " offset " femur dan 5) garis mendatar " offset "femur.

Data yang diperolehi telah dianalisa secara statistic menggunakan " independent T-test " untuk menentukan sama ada terdapat julat perbezaan di antara pesakit lelaki dan perempuan. Purata semua ukuran yang diperolehi dalam kajian ini telah dibandingkan dengan kajian-kajian daripada barat (kulit putih) dan Asia yang lain menggunakan " one sample T-test ".

Keputusan

Terdapat perbezaan ketara di antara kaum lelaki dan perempuan di dalam semua ukuran diameter kepala femur (42.05 $\pm$ 2.39, 38.13$\pm$ 2.22) Diameter terkecil leher femur (29.29 $\pm$ 2.22 , 25.93 $\pm$ 1.89), Garis menegak " offset " femur (52.71$\pm$ 4.98, 47.16$\pm$ 5.22) and garis mendatar " offset " femur (28.54 $\pm$ 3.71, 26.31$\pm$ 3.73).kecuali sudut diantara kepanjangan (shaft) femur dan leher (neck) femur, (138.59 $\pm$ 4.85 , 139.56$\pm$ 4.26) yang mana tiada perbezaan ketara. Kaum perempuan mempunyai ukuran yang lebih kecil dibandingkan dengan kaum lelaki kecuali sudut diantara panjang (shaft) femur dan

leher (neck) femur yang mana sedikit besar dalam pengukuran. Data-data dalam kajian ini telah dibandingkan dengan kajian Noble dan rakan-rakan dan Sugano dan rakan-rakan yang menggunakan filem x-ray (radiographic). Terdapat perbezaan ketara dalam ukuran diameter kepala femur, diameter terkecil leher femur, garisan menegak "offset" femur dan sudut diantara panjang (shaft) femur dan leher (neck) femur. Diameter kepala femur, diameter terkecil leher femur dan garisan menegak "offset" femur dalam kajian ini adalah lebih kecil dibandingkan dengan kajian mereka. Walaubagaimanapun sudut diantara kepanjangan (shaft) femur dan leher (neck) femur dalam kajian ini adalah lebih besar dibandingkan dengan kajian mereka.

Kesimpulan

Kajian yang dijalankan mendapati bahawa pengukuran femur bahagian atas kaum Melayu adalah lebih kecil dibandingkan dengan kaum barat dan penduduk Thailand.

CHAPTER ONE

INTRODUCTION

1.0 INTRODUCTION

An accurate knowledge of the proximal femoral morphology is of utmost importance for a safe screws and hip prosthesis replacement. Screw placement and hip prosthesis fixation is difficult in Asians because of the smaller size and shape which do not accurately match (Mahaisavariya, 2001).

Most of the orthopaedic implants designed for the fixation of proximal femur are based on the Caucasian population. The size and shape do not accurately match with most Asian patients. Mismatching may lead to devastating neurological, imbalance and breaking of the proximal femur during the insertion of the implant. Problems may not occur if the implants are properly designed based on the morphometric data of proximal femur from certain population (Mahaisavariya, 2001). Hence, precise knowledge of the femoral dimensions are essential for safe fixation.

Most of the previous studies on the morphology of proximal femur were done on Caucasian population. Three of these were based on direct cadaveric measurements (Gill et al, 2001; Yoshioka et al,1987 and Zylan, 2002) three on radiologic measurements (Massin et al, 2000; Sugano et al, 1999; Noble et al, 1988) Two on three dimensional computed tomography (3D CT) scanning measurement (Husmann et al, 1997; Bras et al, 2003), Chinese population based on direct CT scanning (Wang et al, 2003), Siamese Population based on cadaveric measurement using 3D CT scan (Mahaisavariya et al, 2001). A number of studies over the past

decade have shown significant differences in the shape of proximal femur between Caucasian and Asian population.

In Thailand the study was based on cadaveric measurement and 108 samples were measured with CT scan and in China 160 healthy Chinese proximal femur images were measured with CT scan. There is no similar study done in Malaysia so far regarding the morphology of proximal femur. Therefore a complete database of the morphology of proximal femur is much needed to ensure a safe and successful proximal femur surgery in Malaysia. We also can manufacture our own implant which is appropriate to our population.

CHAPTER TWO

LITERATURE REVIEW

2.0 Literature Review

2.1 Femur Osteology

Femur is the longest and strongest bone in the skeleton, is almost cylindrical in the greater part of its extent.(Chaurasia, 1981; Gray, 1918). In the standing position, The shaft inclining gradually downward and medialward, for the purpose of bringing the knee-joint near the line of gravity of the body. Femoral obliquity is more in females on account of the greater breadth of the pelvis (Chaurasia, 1981; Gray, 1918; Sinnatamby, 1954).

The head of femur, capped with hyaline cartilage, is more than half a sphere. It is directed upward, medialward, and a little forward, the greater part of its convexity being above and in front. The fovea capitis femoris, which is situated a little below and behind the center of the head, is a small depression and gives attachment to the ligamentum teres. It articulates with the acetabulum to form the hip joint (Chaurasia, 1981; Gray, 1918; Sinnatamby, 1954).

The neck of femur which connecting the head with the shaft, passes downward, backward and laterally and makes an angle of about 125 degrees. The angle is widest in infancy, and becomes lessened during growth . In female, in consequence of the increased width of the pelvis, the neck of the femur forms less angle compared with male. The angle decreases with growth, but after the growth completed, it does not change anymore. The neck has two borders and two surfaces. The upper border is concave and horizontal whereas the lower border is straight and oblique. The anterior

surface is flat and is entirely intracapsular. The posterior surface is convex from above downwards and concave from side to side and its medial half is intracapsular (Chaurasia, 1981; Gray, 1918; Sinnatamby, 1954; Snell, 1995; Noble et al, 1988).

The trochanters are prominent processes which musles attaches to it and rotate the thigh on its axis. They are two in number, the greater and the lesser and located at the junction of the neck and the shaft. The greater trochanter is a large, irregular, quadrangular prominence, situated at the upper part of the junction between neck with the shaft of femur. The upper border of the trochanter is at the level of the centre of the head. It has three surfaces and four borders. The lateral surface, quadrilateral in shape, is for the insertion of the tendon of the Glutæus medius. The medial surface presents a deep trochanteric fossa for the insertion of the tendon of the Obturator externus, and a rough impression for the insertion of the Obsturator internus and Gemelli.

The superior border is thick and irregular, and for the insertion of the Piriformis. The inferior border corresponds to the line of junction of the base of the trochanter with the lateral surface of the body which gives origin to the upper part of the Vastus lateralis. The anterior border is prominent and irregular, for insertion of Glutæus minimus. The posterior border is very prominent and continued down to the lesser throchanter.(Chaurasia, 1981;Gray, 1918; Sinnatamby, 1954; Snell, 1995)

The lesser trochanter directed medially and backward. It is situated at the junction of the posteroinferior part of the neck with the shaft and for attachment of psoas muscle and illiacus muscle (Chaurasia, 1981; Sinnatamby, 1954).

The body or shaft (corpus femoris) is almost cylindrical and slightly broader above , narrowest in the middle and broadest inferiorly. It is slightly arched and convex in front, and concave behind . It is strengthened by a prominent longitudinal ridge, the linea aspera (Chaurasia, 1981; Sinnatamby, 1954; Gray, 1918).

The lower end of the femur has lateral and medial condyle. Anteriorly, the two condyles are united and in line with the shaft of femur. It is separated posteriorly by an intercondylar fossa and project backwards beyond the plane of the popliteal surface.. The lateral condyle slightly forward than medial condyle and helping in stabilize the patella (Chaurasia, 1981; Sinnatamby, 1954; Snell, 1995).

2.2 Femoral Blood Supply

It is important to know the arterial anatomy of the hip to understand of the pathogenesis of disease affecting the proximal portion of the femur and the acetabulum. Arteries that supplies this region are, the lateral femoral circumflex, the medial femoral circumflex, the obturator, the superior gluteal, the inferior gluteal, the first perforating artery and the nutrient artery of the femur.

The lateral femoral circumflex artery originates from the profunda femoris artery and passes laterallv over the iliopsoas and supply muscles (the iliopsoas, the vastus lateralis, and the vastus intermedius and the tensor fasciae latae). the base of the femoral neck, and the greater trochanter. Branches supplying the anterior portion of the femoral neck also originate at the lateral border of the iliopsoas and supply three areas, the base of the neck extracapsularly along the intertrochanteric line, the capsule and the intracapsular neck.

The medial femoral circumflex artery arises from profunda femoral artery. It pass between the illiopsoas and pectineus and supplies the adductor mucles, gracillis and obturator externus. It gives off the lateral epiphyseal and superior and inferior metaphyseal arteries. The lateral epiphyseal artery supply the laterial two third of the femoral head. The superior metaphyseal artery supplies the superior aspect of the femoral neck. The inferior metaphyseal artery supplies the inferior part of the neck.