MEASUREMENT OF MAXIMUM RADIAL BOWING IN MALAY ETHNICITY OF MALAYSIAN

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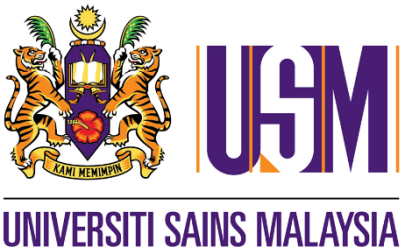
DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF MEDICINE (ORTHOPAEDICS)



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ABSTRAK

Pengenalan

Kajian ini bertujuan untuk menilai tahap maksimum pembengkokan tulang radius dan lokasinya berdasarkan imej AP radiografi radius dan ulna di kalangan etnik Melayu Malaysia. Pengetahuan mengenai pembengkokan tulang radius dan variasi dapat memberi manfaaat untuk membina semula tulang radius.

Kaedah Kajian

Sejumlah 219 imej normal AP radiografi radius dan ulna dinilai menggunakan sistem 'Picture Archiving and Communications System (PACS)'. Tahap maksimum pembengkokan tulang radius dan lokasinya disukat menggunakan kaedah yang diaplikasi oleh Schemitsch dan Richards.

Keputusan

Purata pembengkokan maksimum ialah 13.9mm (SD ± 2.11). Lokasi pembengkokan maksimum adalah 60.3% (SD ± 3.38) dari keseluruhan panjang radius. Berdasarkan penilaian lokasi pembengkokan, perempuan didapati mempunyai pembengkokan tulang radius yang lebih ke bawah berbanding lelaki (61.7% ± 2.93 vs 59.7% ± 3.88). Walau bagaimanapun, lelaki mempunyai lebih banyak magnitud pembengkokan maksimum (14.7mm ± 1.84 vs 12.1mm ± 1.55) dan tulang radius yang lebih panjang (209.9mm ± 12.3 vs 188.1mm ± 12.2). Secara umum, lokasi pembengkokan maksimum tulang radius kiri terletak lebih proksimal berbanding dengan tulang radius kanan sebanyak 1% (59.8 ±3.4 vs 60.9 ±3.3). Tiada perbezaan ditemui

untuk pembengkokan maksimum di antara sebelah kiri dan kanan (14.0±2.1 vs 13.8±2.1). Panjang keseluruhan tulang radius sebelah kiri adalah 1.1mm lebih panjang dari sebelah kanan(203.0±15.3 vs 201.9±15.9).

Kesimpulan

Purata pembengkokan maksimum dan lokasi pembengkokan maksimum di kalangan etnik Melayu adalah 13.9mm (SD ± 2.11) dan 60.3% (SD ± 3.38). Lelaki mempunyai nilai purata yang lebih tinggi jika dibandingkan dengan perempuan.

Kata Kunci:
Kebengkokan radius, pengukuran, radiografi, radius/ulna

ABSTRACT

Introduction

Maximum radial bowing and its locations were studied based on normal anteroposterior (AP) radiograph of radius/ulna within the Malay ethnicity of Malaysians. Knowledge of radial bowing and its variation is beneficial when reconstructing radius.

Material and Methods

Radius AP bowing and its locations were assessed on 219 normal AP radiograph of radius/ulna in Picture Archiving and Communications System (PACS) that meet inclusion and exclusion criteria using the method of Schemitsch and Richards.

Results

The mean maximum radial bowing was 13.9mm (SD±2.11). The location of maximum bowing was 60.3% (SD±3.38) of the total radius length. The bow location was situated more distal in female (61.7% ±2.93) than male (59.7% ±3.88). However, males had more magnitude of radial bowing (14.7±1.84 vs 12.1±1.55) and longer length of total radius measurement (209.9±12.3 vs 188.1±12.2). In general, the left radius bowing location was situated proximally as compared to the right radius by 1% (59.8 ±3.4 vs 60.9 ±3.3). No significant differences were found for magnitude of maximum radial bow in between the left and right radius (14.0±2.1 vs 13.8±2.1). The total length of left radius was found to be 1.1mm longer than right radius (203.0±15.3 vs 201.9±15.9).

Conclusion

The mean maximal radial bowing and mean location of maximal radial bowing in the Malay ethnicity are 13.9±2.1mm and 60.3±3.4% respectively. These values are significantly higher in male as compared to female.

Key Words:

radial bowing, measurement, radiographs, radius/ulna

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Radius and ulna are two long bones at the forearm. Although the radius and ulna function as a unit, they only get contact proximally and distally at the radio-ulnar joints. The anatomy of the radius is incredibly complex that allows it to rotate on ulna during pronation and supination[1]. The transverse diameter size of the radius was broader distally and it has a physiological lateral curvature. It is essential for full rotation of the forearm.

Any fixation of radial shaft fractures needs to be fixed precisely to restore the radial bowing and length especially in case of the instability of either proximal or distal radioulnar joint when only one long bone fracture of forearm occurred[2,3]. Forearm rotation is prone to any malalignment of the radius and accurate rotational as well as axial reduction is critical. The positioning and function of the hand will be impaired in forearm fractures if there is any slight deviation in radius and ulna orientation. It also can affect the rotation of forearms[2,4–6].

Good to the excellent functional outcome was related to an anatomic reduction of fractures. Several studies have shown the importance of radial bow restoration in achieving maximal rotational movement of the forearm after fixation of the long bone of forearm fractures[1,2,7]. Achievement of at least 80 per cent return of the forearm movement can be observed when radius fracture heals in a more anatomical position[2]. The probabilities of attaining full supination were more when near-normal restoration of the radial bow but it had less effect on pronation[1].

Special attention needs to be given when managing those fractures either non-operative or operatively. Improper reduction alignment in term of length and radial bow can lead to poor hand function and muscle imbalance. There was no statistical difference was found following plate fixation of the fractures of both bones of the forearm in the mean maximal radial bow and its location between injured and non-injured forearm[8].

In the Malaysian population, no study was conducted previously thus no available data on the maximum magnitude of radial bowing and its location. The purpose of this study was to measure the mean maximal radial bowing and determine the mean location of maximal radial bowing among skeletally mature bone of Malay's ethnicity in Malaysia. This study also can evaluate any differences in the maximum magnitude of radial bowing and its location between gender in Malay Ethnicity population in Malaysia. A better understanding can be obtained regarding the maximum magnitude of radial bowing and its location in which might be useful when reconstructing radius for cases of comminuted fracture or bone loss.

1.2 OBJECTIVE

General

To study the normal bowing of the radius in normal anterior-posterior (AP) radiograph of radius/ulna in skeletally mature bone of Malay ethnicity of Malaysian's population

Specific

1. To measure the mean maximum radial bowing among skeletally mature bone of Malay's ethnicity in Malaysia
2. To determine the mean location of maximum radial bowing among skeletally mature bone of Malay's ethnicity in Malaysia
3. To compare the mean maximum radial bowing and its location between gender of Malay's ethnicity in Malaysia

CHAPTER 2: STUDY PROTOCOL

2.1 DISSERTATION PROTOCOL

DISSERTATION PROPOSAL

TITLE:

Measurement of Maximum Radial Bowing in Malay Ethnicity of Malaysian

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INTRODUCTION

The forearm serves an important role in the upper extremity function, facilitating positioning of hand in space thus helping to provide upper extremity with mobility. Fractures of radius and ulna are relatively common injuries. Malunion and non-union occur more frequently because of difficulty in reducing and maintaining reduction of two parallel bones in presence of supinating and pronating muscles that have angulating and rotational influences. Restoration of length, opposition, axial and rotational alignment must be achieved if a good range of pronation and supination is to be restored.

Bowing of the radius is of crucial importance to the normal range of rotation of the forearm where the radius rotates around the fixed ulna and to the strength generated by the muscles. Several studies have shown the importance of restoration of radial bow in achieving maximal rotational movement of forearm after plate fixation of fractures both bones forearm.

However, there was no data on maximum site of radial bowing and its location in Malay population. This study can give better understanding on maximum site of radial bowing and its location, and any difference between gender in Malay Ethnicity population in Malaysia.

PROBLEM STATEMENT & STUDY RATIONALE

Chronic disorders of the forearm interfere with the stability, strength, and rotatory motion required to allow effective function of the hand. The radial bow plays an important role in supination and pronation of the forearm where the radius rotates around the fixed ulna. In case of comminuted or segmental fracture of radius, restoration of radial bow should be achieved as near normal as possible as it can affect supination and pronation of forearm. Does maximum radial bowing and its location same in all skeletally mature bone's population? However, there are lack of available data on radial bowing for our population. The goal is to determine maximum radial bow and the location of maximum radial bow in Malaysian population and compare is there any difference in between gender for maximum radial bow and its location.

TARGET RESEARCH QUESTION(s)

1. Does maximum radial bowing same in all skeletally mature bone's population?
2. Does location of maximum radial bowing same in all skeletally mature bone's population?
3. Is there any significant difference of maximum radial bowing and its location between gender of Malay's ethnicity in Malaysia?

OBJECTIVE

General

To study the normal bowing of the radius in normal anterior-posterior (AP) radiograph of radius/ulna in skeletally mature bone of Malay ethnicity of Malaysian's population

Specific

1. To measure the mean maximum radial bowing among skeletally mature bone of Malay's ethnicity in Malaysia
2. To determine the mean location of maximum radial bowing among skeletally mature bone of Malay's ethnicity in Malaysia
3. To compare the mean maximum radial bowing and its location between gender of Malay's ethnicity in Malaysia

LITERATURE REVIEW

Functions of the forearm and hand are dependent on the combination of stability and mobility. In the fractures of the forearm return of function depends on the union of fracture and rotations of the forearm. Physiological bowing is essential for full rotation of the forearm.

The normal anatomical radial bow is of crucial importance to the normal range of motion of the forearm and to the strength generated by the muscles. The restoration of the normal amount and location of the radial bow is of crucial importance in functional outcome of forearm fractures. In forearm fractures every effort must be made to restore the radial bow close to the values of the normal limb for better functional outcome.

The restoration of forearm bow, as assessed by the maximal radial bow and its location, is crucial for the return of rotation. Patients with return of forearm movement of at least 80% had more anatomical healing of the radius as assessed by the maximal radial bow and its location compared with those with less than 80% [2].

The magnitude of radial bow had positive, statistically significant relation to the supination achieved. The nearer to normal restoration of radial bow, the more were the chances of achieving full supination. It had a lesser impact on pronation which was statistically not significant and a negative statistically insignificant relation to DASH scores[1].

Pronation and supination of the forearm and flexion and extension of the wrist were specifically assessed for their relationship to the maximal radial bow and its location. As the difference from the normal maximal radial bow increased, regardless of whether it was greater or less than normal, supination of the injured limb also increased [7] .

Anatomic reduction was associated with good to excellent functional outcome. There were no statistical difference in mean maximal radial bow (MRB) or location of MRB between injured and non-injured arm was found following plate fixation of fractures of both bones of the forearm [8].

Acute bowing of the bones of the forearm in children following trauma has only recently been recognized as a clinical and radiographic entity. This type of injury has been overlooked in the past because of lack of familiarity with the mechanical properties of curved tubular bones. Absence of a fracture line and the usual findings associated with a healing fracture on radiographs has contributed to the lack of recognition of this condition [9]. Measurement of bowing in children is of help in diagnosing bowing fractures and allows more detailed estimation of the process of diaphyseal remodelling [3].

This study provides information that can be useful for the diagnosis of bowing and for the evaluation of post-traumatic deformities.

RESEARCH DESIGN

This is a cross-sectional study using secondary data based on Picture Archiving and Communications System (PACS) database from Hospital Universiti Sains Malaysia (HUSM).

STUDY AREA

The study will be conducted in HUSM which started operation in the year 1983. HUSM is a tertiary referral centre and a teaching hospital in Kelantan, at the east coast region of Peninsular Malaysia. HUSM is a trauma centre in which a majority of patient with trauma undergo radiographs of radius and ulna to ruled out fractures providing enough patients fulfilling inclusion criteria for this study.

STUDY POPULATION

My reference population will be individuals of Malay ethnicity in Malaysia whereas my source population are individuals that presented to HUSM Emergency Department. My target population are Malay ethnicity patient that had normal AP radiograph of radius/ulna in skeletally mature bone in HUSM Emergency Department. My sampling frame will be patient normal AP radiograph of radius/ulna database in PACS.

SUBJECT CRITERIA

A. Inclusion criteria

1. Normal AP radiography of radius/ulna
2. Skeletally mature bone
3. Malay ethnicity

B. Exclusion criteria

1. Patient age: male <18 years old and female < 16 years old
2. Previous radius and ulna bone fracture or wrist/elbow joint subluxation/dislocation
3. Congenital deformity
4. Pathology bone – osteomyelitis, tumour

SAMPLE SIZE ESTIMATION

1. The estimated sample size for objective 1 using single mean formula
    - $n = (Z*\sigma/\Delta)^2$
        - Z: 1.96
        - Δ: 0.5
        - σ : 1.03 (SD of maximum bowing based on thesis by Firl 2004)
    - n = 16
2. The estimated sample size for objective 2 using single mean formula
    - $n = (Z*\sigma/\Delta)^2$
        - Z: 1.96
        - Δ: 0.5
        - σ : 3.74 (SD of site of maximum bowing based on thesis by Firl 2004)
    - n = 215
3. The estimated sample size for objective 3 using PS software
    - α: 0.05
    - *Power:* 0.08
    - δ: 2
    - *m:* 1
    - σ: 3.74 (SD of site of maximum bowing based on thesis by Firl 2004)
    - Sample size: 56
    - Total sample size for 2 groups is 112
4. No drop out calculated as the study is using data from the PACS database. Therefore, sample size required is 215 patients

SAMPLING METHOD AND SUBJECT RECRUITEMENT

Non-probability sampling is used to select patients from the PACS database, who is Malay ethnicity that done normal AP radiograph of radius/ulna falls into the inclusion and exclusion criteria. Subject recruitment is not required as data is obtained from the system.

RESEARCH TOOL

Normal AP radiograph of radius/ulna are measured using the measurement tool of the workstation Centricity^{TM} Universal Viewer Web Client Version 6.0 by GE Healthcare by 2 persons which are Nurul Ayuni Maznon and Nur Sabrina Abdul Ghani for all the parameters and documented in millimetre (mm) rounded up to one decimal point.

OPERATIONAL DEFINITIONS

i. Normal AP radiograph of radius/ulna is defined as the bicipital tuberosity and radial styloid should be 180 degrees apart

ii. Length of entire radius bow is defined as the distance from the mid-point of the bicipital tuberosity to the most ulnar aspect of the subchondral done of the distal part of the radius

iii. Maximum radial bow is defined as height of perpendicular line drawn from the point of the maximum radial bow to a line of length of entire radius bow

iv. Location of maximum radial bow is defined as the distance from the bicipital tuberosity to previously measured perpendicular line at the point of the maximum radial bow and is recorded as a percentage of the length of the entire bow

LIST OF ABREVIATIONS

i. AP refers to anterior posterior

ii. MRB refers to maximum radial bow

iii. LMRB refers to location of maximum radial bow

iv. PACS refers to Picture Archiving and Communications System

v. HUSM refers to Hospital Universiti Sains Malaysia

vi. SD refers to Standard Deviations

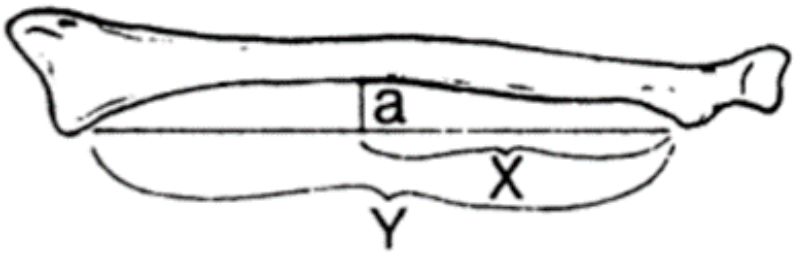
vii. MREC refers to Medical Research and Ethics Committee

DATA COLLECTION METHOD

Data will be collected by measuring normal AP radiograph of radius/ulna from the PACS database. Patient's participation is not required, and data will be collected with strict confidentiality. Normal AP radiograph (Figure 1) will be measured according to the method shown in Figure 2 and 3.

To measure the radial bow, a line is drawn from the bicipital tuberosity to the most ulnar aspect of the radius at the wrist (Y). A perpendicular line is then drawn from the point of the maximum radial bow to this line. The height of the perpendicular line (the maximum radial bow) is measured in millimetres. The distance from the bicipital tuberosity to the previously measured perpendicular line at the point of the maximum radial bow is then measured and is recorded as a percentage of the length of the entire bow (the distance from the mid-point of the bicipital tuberosity to the most ulnar aspect of the subchondral bone of the distal part of the radius). This measurement is termed the location of the maximum radial bow.

Figure 1: Radiograph of normal AP left radius/ulna



MAXIMUM RADIAL BOW

a (mm)

LOCATION OF MAXIMUM RADIAL BOW

x/y x 100

Figure 2 : Schematic diagram how to determine maximum radial bow and location of maximum radial bow; line(Y) is drawn from the bicipital tuberosity to the most ulnar aspect of the radius at the wrist; perpendicular line(a) is then drawn from the point of the maximum radial bow to this line; the distance(X) from the bicipital tuberosity to the previously measured perpendicular line(a) at the point of the maximum radial bow

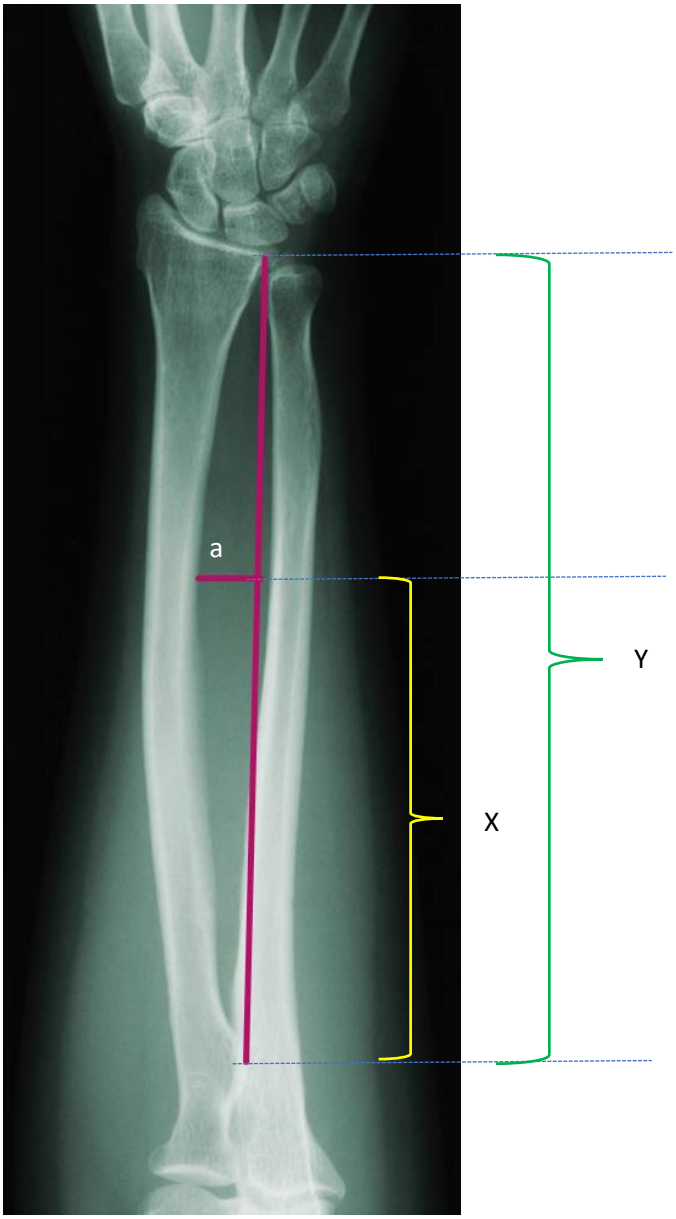


Figure 3 : Diagrammatic illustration of measurement of maximum radial bow and location of maximum radial bow on radiograph of normal AP left radius/ulna; line(Y) is drawn from the bicipital tuberosity to the most ulnar aspect of the radius at the wrist; perpendicular line(a) is then drawn from the point of the maximum radial bow to this line; the distance(X) from the bicipital tuberosity to the previously measured perpendicular line(a) at the point of the maximum radial bow Radiograph of a normal forearm in neutral rotation, showing the technique of measurement.

DATA COLLECTION SHEET

Data Collection Sheet

Registration number:

Age:

Sex: ☐ Male ☐ Female

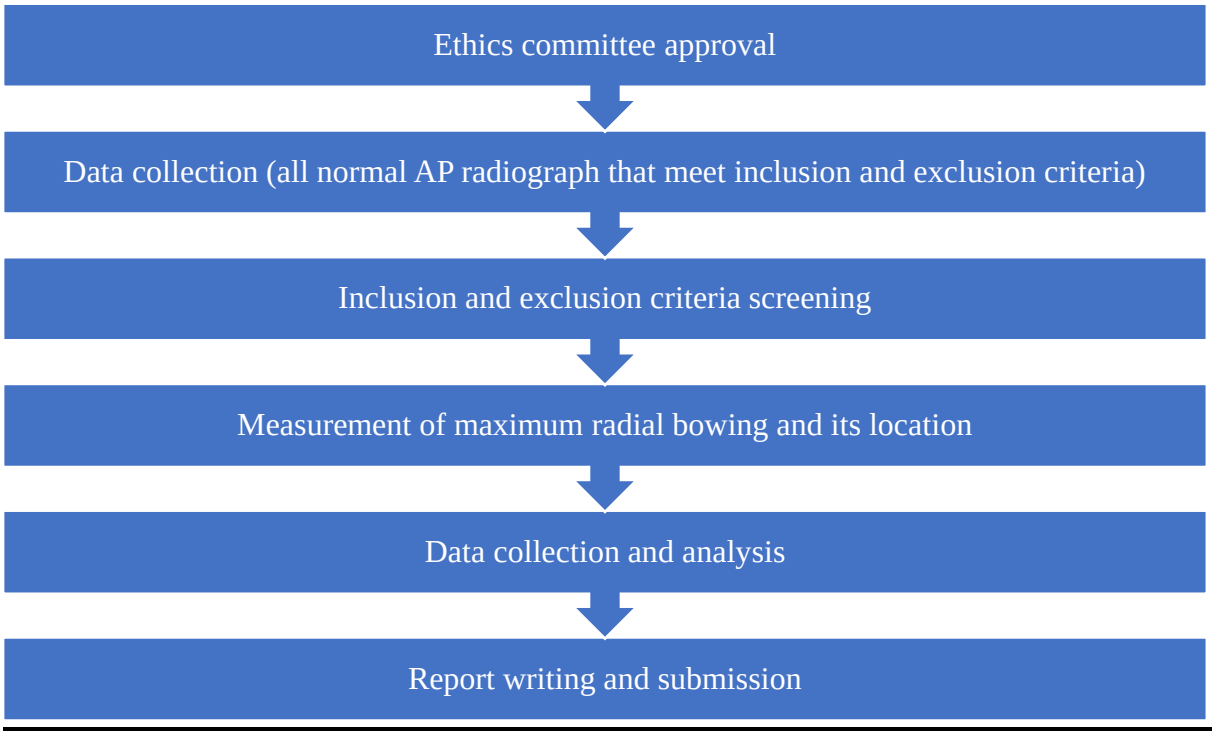
Site: ☐ Left ☐ Right

Length of entire radial bow (mm) _____

Maximum radial bowing (mm) _____

Location maximum radial bowing (mm) _____

STUDY FLOW CHART



DATA ANALYSIS

Data will be entered and analysed using SPSS version 24. Descriptive statistic will be used to summarise the socio-demographic characteristics of subjects. Numerical data will be presented as mean (SD) or median (IQR) based on their normality distribution. Categorical data will be presented as frequency (percentage). Independent t-test will be used to compare the mean maximum radial bowing and its location between gender.

Dummy tables for data analysis

Table 1: Characteristic of Radius based on AP radiograph radius/ulna

	Mean (SD)	Range
Maximum radial bow, a (mm)		
Location of maximum radial bow (%)		
Total length of radius, Y (mm)		