

Index to Ring Finger Ratio : A Predictor of Osteoarthritis

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Abstract : Osteoarthritis (OA) is a degenerative joint disease affecting the articular cartilage with a multifactorial aetiology. Clinically determined markers of risk could prove useful for identifying people for appropriate targeting of primary prevention measures. The ratio of the lengths of the second digit (2D) or index finger, to the fourth digit (4D) or the ring finger, is a sexually dimorphic trait such that males tend to have a lower mean 2D:4D ratio than females. The 2D:4D ratio has been associated with a variety of traits. This study evaluates the contribution of the phalanges and metacarpals to the 2D:4D ratio, and also the relationship between 2D:4D ratio and knee osteoarthritis. The 2D:4D ratio was lower in males than females. There was a significant difference between the phalangeal 2D:4D ratios for males and females in cases of OA. The metacarpal 2D:4D ratios for males and females showed a significant relationship with early changes of Osteoarthritis on knee radiograph. The metacarpals and phalanges both contribute to variation in 2D:4D ratio. The metacarpal 2D:4D ratio may serve as a marker for evidence of occurrence of osteoarthritic changes in the knee.

INTRODUCTION

Osteoarthritis (OA) is a degenerative joint disease affecting the articular cartilage with a multifactorial aetiology. It can be primary occurring de novo in a joint, or secondary to an underlying disease of the joint. Clinically determined markers of risk could prove useful for identifying people for appropriate targeting of primary prevention measures¹. The ratio of the lengths of the second digit (2D) or index finger, to the fourth digit (4D) or the ring finger, is a sexually dimorphic trait such that males tend to have a lower mean 2D:4D ratio than females². The 2D:4D ratio has been associated with a variety of traits^{3,4,5}. Men typically have a shorter index finger compared with the ring finger (type 3 pattern), while the fingers have more equal length in women⁶.

OBJECTIVES

The objectives of this study were to assess the contribution of the phalanges and metacarpals to the 2D:4D ratio, and to evaluate the relationship between 2D:4D ratio and knee osteoarthritis.

METHODS

This is a prospective case control study carried out at a tertiary health care center over a period of 2 months. The study was approved by the Institute Review Board. 100 cases were included in the study (Group A: 50 patients of knee osteoarthritis and Group B: 50 controls). Written and informed consent was obtained from all participants before start of study. Cases of rheumatoid arthritis, gout and meniscal injuries were excluded from the study. The clinical examination was performed by an orthopaedician. Right and Left hand and knee radiographs were taken for every individual. Case was defined when a radiographic structural evidence of disease was found. The radiographs were interpreted by a single certified radiologist who was blinded to the information about the individual study participant.

Hand Radiographs

Separate radiographs of the right and the left hand were obtained.

Participant were seated adjacent to the X-ray table, with forearm and hand flat and prone on the table with no lateral angulation at the wrist. The hand was centered on the cassette with the fingers slightly spread apart but flat. The X-ray beam was centered on the third metacarpophalangeal joint. Hand Osteoarthritis was defined as evidence of disease in one or more of the following bilateral joints:

Second distal interphalangeal joint, Third proximal interphalangeal joint and First carpometacarpal joint.

Knee Radiographs

Posterior-anterior weight bearing knee radiographs (right and left) were obtained with the feet externally rotated 10 degrees, and the knees and thighs touching the vertical platform and the X-ray beam angled 10 degrees caudally. Skyline 30-degree views of both patellofemoral compartments were obtained with the participants seated and the beam were angled from feet to knees. Each knee radiograph was graded 0 to 4 for osteoarthritis using the Kellgren-Laurence Criteria⁷.

Radiographic measurements (length in mm) were taken for index and ring fingers of both hands by one observer. The 2D:4D ratios were calculated (Phalangeal 2D:4D ratio : Length of the second phalanx divided by the length of the fourth phalanx. Metacarpal 2D:4D ratio: Length of the second metacarpal divided by the length of the fourth metacarpal) and comparison of metacarpal and phalangeal 2D:4D ratios with radiographic evidence of osteoarthritis was documented. The Chi-square test was used for statistical analysis.

RESULTS

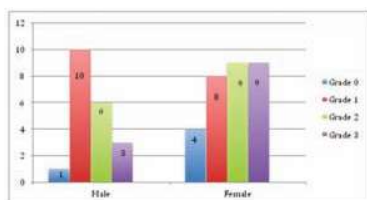
Majority of the patients included in the study were in the age group of 35 to 45 years. 54% were males. In Group A, the cases of osteoarthritis were distributed across the age group of 35-75 years, out of which 60% were females. The 2D:4D ratio was lower in males than females. There was a significant difference between the phalangeal 2D:4D ratios for males and females in Group A (Table 1). 38% of the cases included in the study had Grade I osteoarthritic changes on the knee radiograph (Graph 1). By grouping the early and late osteoarthritic changes, there was no significant relationship between early/late osteoarthritic changes and the visual classification in males and females (Table 2).

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Table1: Phalangeal and Metacarpal 2D:4D ratio in males and females

Parameter	Group A				p value	Group B				
	Males (n=20)		Females (n=30)			Males (n=33)		Females (n=17)		
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Metacarpal 2D:4D	1.21	0.03	1.26	0.02	<0.0001	1.19	0.04	1.18	0.05	>0.05
Phalangeal 2D:4D	0.90	0.03	0.91	0.01	<0.05	0.91	0.02	0.92	0.03	>0.05

Chi-Square test



Graph 1: Grading of Knee Osteoarthritis by KL Classification

Table 2: Visual Classification and Knee osteoarthritis

Visual Classification	Male osteoarthritis			Female osteoarthritis		
	Grade I	Grade II	Grade III	Grade I	Grade II	Grade III
Type 1	2	1	-	6	3	3
Type 2	-	-	-	1	5	4
Type 3	9	5	2	1	1	3
Total	11	6	2	8	9	10
Chi-square	0.07			1.71		
p Value	>0.05			>0.05		

Chi-Square test

The metacarpal 2D:4D ratios for males and females showed a significant relationship with early changes of Osteoarthritis on knee radiograph (Table 3). The Phalangeal 2D:4D ratios for males and females suggested no significant relationship with findings of early/late changes of Osteoarthritis on knee radiograph (Table 4).

Table 3: Knee Radiograph features and Metacarpal 2D:4D Ratios

KL Classification	Metacarpal 2D:4D (Mean Value)		t Value	p Value
	Male	Female		
Grade I	1.22 ± 0.03	1.26±0.03	2.82	<0.05
Grade II +III	1.21 ± 0.03	1.27±0.02	4.87	<0.001

Chi-Square test

Table 4: Knee Radiograph features and Phalangeal 2D:4D Ratios

KL Classification	Phalangeal 2D:4D (Mean Value)		t Value	p Value
	Male	Female		
Grade I	0.90 ± 0.03	0.92 ± 0.02	1.93	>0.05
Grade II +III	0.90 ± 0.02	0.91 ± 0.01	1.59	>0.05

Chi-Square test

DISCUSSION

The 2D:4D ratio was lower in males as compared to females. There was a significant difference in the phalangeal 2D:4D ratios for males and females affected by osteoarthritis. In cases of osteoarthritis, Type 1 pattern (Index finger longer than ring finger) demonstrated a significant relationship with the metacarpal 2D:4D ratio, the difference in the ratios between males and females being statistically significant. The phalangeal 2D:4D ratio did not show any significant correlation with visual classification patterns. This study confirms that the 2D:4D ratio is measurable on radiographs and differentiates between male and female hands in accordance with several studies in literature^{8,9,10}.

Robertson *et al*¹¹ have investigated the metacarpal length separately and concluded that the 2D:4D metacarpal ratio also differentiates

between male and female hands with the male mean ratio being significantly less than the female. Our study has demonstrated a significant difference in the 2D:4D phalangeal ratio in males and females.

Zhang *et al*¹² have mentioned that the 2D:4D length ratio is an identified risk factor for the development of osteoarthritis; specifically women with male pattern of 2D:4D ratio are more likely to develop knee osteoarthritis. The exact mechanism is not known. There study found no supporting evidence to suggest that the 2D:4D length ratio operates through high level of physically activity or via surrogates of male hormone levels such as shaving frequency, occurrence of adult acne or male pattern baldness. They concluded that the smaller 2D:4D length ratio assessed from hand radiographs is associated with an increased risk of knee osteoarthritis.

There is accumulating data that type 3 finger pattern is positively associated with athletic ability. It has been associated with achievement in many competitive and physically demanding sports^{13,14}. Haugen *et al*¹⁵ conducted a cross sectional study including 1039 participants from the Framingham community cohort. There were no significant associations between 2D:4D and radiographic knee osteoarthritis, severe symptomatic knee osteoarthritis and or meniscal lesions.

Ferraro *et al*¹ conducted a case control study with 236 cases in each group. The type 3 finger pattern was associated with knee osteoarthritis. Women demonstrated its stronger association of visual type 3 finger pattern and knee osteoarthritis. In our study, type 1 finger pattern demonstrated a significant relationship with 2D:4D ratio.

Hussain *et al*¹⁶ have reported that a lower index-to-ring finger length ratio (2D:4D) is associated with an increased risk of severe knee OA. Knee osteoarthritis has been associated with knee height.

CONCLUSIONS

The metacarpals and phalanges both contribute to variation in 2D:4D ratio. The 2D:4D ratio differentiates between male and female hands, the ratio being less in men. The visual classification of 2D:4D ratio is a simple tool for assessment based on hand radiographs, the type 3 finger pattern being commoner in males. The metacarpal 2D:4D ratio may serve as a marker for evidence of occurrence of osteoarthritic changes in the knee.

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