International Journal of Anatomy and Research,
Int J Anat Res 2019, Vol 7(1.3):6314-18. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2019.108

Original Research Article

CARPAL HEIGHT RATIO IN KASHMIRI POPULATION: A STUDY OF ONE HUNDRED AND TWENTY WRIST RADIOGRAPHS

Masarat Jehan [1], Nadeem Ali *[2], Mohammad Saleem Itoo [3], Shaheen Shahdad [4], Altaf Ahmad Kawoosa [5].

[1] Postgraduate scholar, Department of Anatomy, GMC Srinagar, Jammu & Kashmir, India.

[*2] Lecturer, Hospital for Bone and Joint Surgery Barzulla, Srinagar, Jammu & Kashmir, India.

[3] Associate Professor, Department of Anatomy, GMC Srinagar, Jammu & Kashmir, India.

[4] Professor, Department of Anatomy, GMC Srinagar, Jammu & Kashmir, India.

[5] Associate Professor, Hospital for Bone and Joint Surgery Barzulla, Srinagar, Jammu & Kashmir, India.

ABSTRACT

Background: Morphometry of the human skeleton not only varies from one ethnic group to another but also between the individuals of the same race. The morphometric measurements of human skeleton have implications in orthopaedic surgery with respect to diagnosis of the pathology as well as with respect to surgical treatment of the same. One such important index in orthopaedics is the carpal height ratio. In this study we evaluated the carpal height ratio using different methods in our healthy population to formulate a reference database with which a pathological value can be compared and also compared our data with that of the different races in the literature.

Subject and Methods: This study was conducted on 120 normal wrist radiographs. The carpal height ratio and the revised carpal height ratio were calculated using Youm's and Nattrass methods respectively. The results were evaluated statistically and the ratios between two age groups and between male and female gender were compared using t-test. A p-value of > 0.05 was considered as statistically significant.

Results: The age of the patients ranged from 19 to 60 years with a mean of 39.2 years. The mean carpal height ratio was 0.52 ± 0.05 (range 0.45 to 0.63) and the revised carpal height ratio ranged from 1.42 to 1.61 with a mean of 1.50 ± 0.06. There was no statistically significant difference in these ratios between the two age groups and between the genders.

Conclusion: A reference database of Youm's carpal height ratio and Nattrass revised carpal height ratio in our population has been formulated. We did not find any significant difference of these ratios between male and female wrists and also these ratios do not change significantly with the advancing age.

KEY WORDS: Carpal height, Youm's, Nattrass, Kienbock's, Carpal collapse.

Address for Correspondence: Dr Nadeem Ali, Mughal Mohalla, Lalbazar, Srinagar, Jammu & Kashmir, India – 190023.Mobile no.: 919622795472; 911942423211 **E-Mail:** drnadeeem@gmail.com

Access this Article online	Journal Information
Quick Response code	**International Journal of Anatomy and Research** ICV for 2016 90.30 ISSN (E) 2321-4287 | ISSN (P) 2321-8967 **https://www.ijmhr.org/ijar.htm** **DOI-Prefix:** https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2019.108	**Article Information** Received: 10 Jan 2019 Accepted: 15 Feb 2019 Peer Review: 10 Jan 2019 Published (O): 05 Mar 2019 Revised: None Published (P): 05 Mar 2019

INTRODUCTION

Despite advances in the radiological modalities, a simple radiograph of the wrist is a basic tool for evaluation of the wrist pathology. Besides the normal anatomy of the carpus that can be evaluated on a wrist radiograph, there are

numerous radiological indices that can be altered in wrist pathologies [1]. One such important radiological index is the carpal height ratio which can predict the carpal collapse as seen in many conditions of the wrist like avascular necrosis of the lunate (Kienbock's disease) and wrist arthritis of any aetiology (primary, rheumatoid, post infectious, post traumatic, many more). The concept of wrist radiographic measurements dates back to 1978, when Youm et al introduced and measured carpal height, carpal height ratio and carpal-ulnar distance [2, 3]. These radiological indices and ratios may vary with the race and ethnicity and hence there should be a standard reference database for every race and population with which a pathological value can be compared.

In this study we evaluated the carpal height ratio by simple plain radiography of non-pathological wrists to formulate a reference database of our healthy population and also compared the values for any possible difference between different age groups and genders. A comparison was also made with the international literature for any variation between different races.

SUBJECT AND METHODS

This prospective study was conducted in Accident and Emergency of a tertiary care orthopaedic centre of India from March 2018 to November 2018 on a total of 120 wrist radiographs of patients aged 18 years and above. Standard postero-anterior radiographs of normal contra lateral wrists taken for comparison in distal end radial fractures and of wrist trauma patients without any bony or ligamentous injury were studies. Patients below 18 years of age, or with history of previous wrist or hand trauma, operative intervention of the wrist, any form of arthritis (rheumatoid, post-traumatic, post infectious, or idiopathic), chronic wrist pain and those with congenital anomalies of the upper extremities were excluded from this study. WrWrist radiographs with any evident pathology, though asymptomatic, were also excluded.

All the postero-anterior wrist radiographs were taken by placing the beam vertical to radial styloid with wrist in neutral position in both saggital and coronal planes with elbow flexed to 90° and shoulder abducted to 90°.

The radiograph also included full length of the third metacarpal. The linear measurements were taken in millimetres and included length of the third metacarpal, carpal height and length of the capitate. The length of third metacarpal was measured along its longitudinal axis from distal articular surface to proximal articular surface (L_1). The carpal height was measured on the proximal extension of the longitudinal axis of the third metacarpal from the articular surface of base of the third metacarpal to the distal articular surface of the radius (L_2) (Fig. 1). The capitate length is the longest distance from subchondral margin of its distal pole at capitate-third metacarpal joint to subchondral margin of its proximal pole at the inter-carpal joint (L_3) (Fig. 1). The carpal height ratio was calculated by two methods, namely, Youm's and Nattrass methods. In Youm's method, the carpal height ratio (CHR) was obtained by dividing the carpal height by the length of the third metacarpal (L_2 / L_1) and in Nattrass method a revised carpal height ratio (CHRr) was obtained by dividing the carpal height by the length of the capitate (L_2 / L_3).

Analysis of the data was done by statistical package for social sciences (SPSS version 16.0). To describe the continuous variables, the data was expressed in the form of mean and standard deviation. t-test was used for analysis of results between the genders and different age groups (≤ 40 year age group and > 40 year age group). A *p* value of less than 0.05 was considered as statistically significant.

RESULTS

Fig. 1: Radiograph on the left hand side showing measurement technique of third metacarpal length (L_1) and carpal height (L_2) and on the right hand side showing capitate length (L_3).

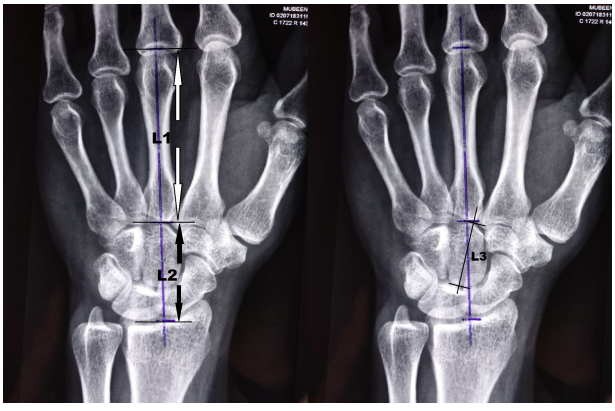

Table 1: Radiographic measurements of carpal height ratio in all one hundred and twenty subjects.

Ratio	Minimum	Maximum	Average ± SD
CHR	0.45	0.63	0.52 ± 0.05
CHRr	1.42	1.61	1.50 ± 0.06

SD: Standard deviation; CHR: Carpal height ratio; CHRr: Revised carpal height ratio

Table 2: Difference in carpal height ratio between two age groups.

Ratio	Age group ≤ 40 years Range (Mean ± SD)	Age group > 40 years Range (Mean ± SD)	p-value
CHR	0.45 to 0.63 (0.53 ± 0.05)	0.47 to 0.57 (0.52 ± 0.04)	0.3
CHRr	1.42 to 1.61 (1.50 ± 0.07)	1.42 to 1.61 (1.49 ± 0.06)	0.82

SD: Standard deviation; CHR: Carpal height ratio; CHRr: Revised carpal height ratio

Table 3: Difference in carpal height ratio between genders.

Ratio	Male Range (Mean ± SD)	Female Range (Mean ± SD)	p-value
CHR	0.45 to 0.63 (0.53 ± 0.05)	0.47 to 0.57 (0.51 ± 0.03)	0.05
CHRr	1.42 to 1.61 (1.49 ± 0.06)	1.42 to 1.61 (1.50 ± 0.06)	0.25

SD: Standard deviation; CHR: Carpal height ratio; CHRr: Revised carpal height ratio

Table 4: Comparison of carpal height ratio (CHR) of our study with other studies in the literature.

Study	Year	Place of study	Number of subjects	Range of CHR	Mean CHR
Youm Y et al	1978	-	-	-	0.54 ± 0.04
Stahelin A et al	1989	Switzerland	58	-	0.54 ± 0.04
Schuind FA et al	1992	Minnesota	120	0.46 to 0.61	0.53
Safikhani Z et al	2000	Iran	230	-	0.54 ± 0.04
Wang YC et al	2010	Taiwan	261	0.43 to 0.59	0.51 ± 0.03
Foteva N et al	2010	Macedonia	100	0.51 to 0.57	0.53 ± 0.015
Jafari D et al	2012	Iran	150	0.46 to 0.60	0.52
Present study	2018	India	120	0.45 to 0.63	0.52 ± 0.05

Table 5: Comparison of revised carpal height ratio (CHRr) of our study with other studies in the literature.

Study	Year	Place of study	Number of subjects	Range of CHRr	Mean CHRr
Nattrass GR et al	1994	Canada	100	-	1.57 ± 0.05
Torres-Gonzalez R et al	2006	Mexico	112	-	1.45 ± 0.1
Foteva N et al	2010	Macedonia	100	1.50 to 1.61	1.56 ± 0.02
Jafari D et al	2012	Iran	150	1.2 to 2.0	1.4 ± 0.09
Present study	2018	India	120	1.42 to 1.61	1.5 ±0.06

A total of 120 patients were enrolled for the study. The age of the patients ranged from 19 to 60 years with a mean of 39.2 ± 14.79 years. There were 64 (53.33 %) male patients and 56 were females. The age of the male patients ranged from 19 to 60 years with an average of 35.13 ± 14.41 and that of female patients ranged from 22 to 60 years with a mean age of 43.86 ± 13.93 years. 60 % of the wrist radiographs were of the right wrist and the remaining 40 % were of the left extremity. CHR of the patients ranged from 0.45 to 0.63 with an average of 0.52 and CHRr ranged from 1.42 to 1.61 with a mean ratio of 1.5 (Table 1). The range of CHR and CHRr and their mean of all the subjects, of the two age groups and of both the genders have been summarized below (Table 2, and Table 3). There was no statistically significant difference of CHR and CHRr between the two age groups and between male and female subjects.

DISCUSSION

The concept of carpal collapse was introduced by Youm Y et al and is a feature of many pathological conditions of the wrist characterized by progressive loss of the carpal height as the disease progresses [2, 3]. Various pathologies that may lead to loss of carpal height include osteonecrosis of the lunate, non-union of the scaphoid, carpal instability and any type of arthritis involving the wrist. As the height of the carpus will vary grossly among individuals and will also vary with the degree of magnification of the radiographs, the best method to express this concept of carpal collapse is by use of a ratio as given by Youm et al (Carpal height ratio) in 1978 [2, 3]. Many wrist radiographs do not have full length of the third metacarpal for calculation of the carpal height ratio (CHR). To overcome this problem Nattrass et al in 1994 introduced a new method of measuring the degree of carpal collapse that did not involve the measurement of third metacarpal height and expressed it as a ratio between carpal height to the length of the capitate. This new ratio is known as revised carpal height ratio (CHRr) [4]. In this study we have used both the methods to formulate a normal reference range of both CHR and CHRr in our population. These important wrist radiographic indices are important to follow the cases of wrist pathologies and since there may be ethnic variation of these indices, it is important to have a reference value for each race with which a pathological value can be compared.

Daza L et al in their study on carpal collapse in

rheumatoid arthritis found 88 patients out of 97 had carpal collapse (CHR ≤ 0.43) in one or both the wrists while as the healthy control group had a mean CHR of 0.49 ± 0.02 [5]. In a similar type of study on rheumatoid arthritis by Ucan H et al had an average CHR of 0.47 in the patient group and 0.54 in the healthy control group. However, carpal collapse was considered as a CHR < 0.48 [6]. This difference on selection criteria for carpal collapse is based on the baseline reference value of CHR of a population. Mack GR et al in their study on natural history of scaphoid non-union found carpal height ratio progressively decreased with the duration of the non-union with carpal collapse in 18 % of non-unions at 5 to 9 years and in 50 % at duration of 20 years and above. In their study carpus was labelled to be collapsed when CHR was ≤ 0.50 [7].

The average CHR in different studies, from different races, ranges from 0.51 to 0.54 [2, 3, 8, 9, 10, 11, 12, 13]. The mean CHR in our study was 0.52 which is same as that of Jafari D et al from Iran (Table 4) [13]. The average CHRr from different studies in the literature ranged from 1.4 to 1.57 and that of our study averaged 1.5 (Table 5) [4, 12, 13, 14].

Like studies by Jafari et al, and Foteva M et al our study also did not have any statistically significant difference in the CHR and CHRr between the two age groups and between the male and female subjects [12, 13]. However, in a study by Wang YC et al the mean CHR of male and female subjects in Taiwanese population was 0.52 and 0.50 respectively with a statistically significant difference ($p < 0.01$) [11]. In our study, the average CHR of male and female subjects was 0.53 and 0.51 respectively which was not statistically significant. So these carpal indices do not only vary from one ethnic group to another but there may be a difference between different age groups as well as between the genders. However, we did not have any such difference with respect to age and gender.

CONCLUSION

From this study we formulated a reference data base of carpal height ratio as well as of the alternative ratio of revised carpal height ratio in our population. Our data is comparable to many of the studies from different races and ethnic groups. We did not find any significant change in these ratios with the advancing age and also did not find any significant difference between the two genders. This data can be used in future for making diagnosis and for the follow up of the patients with wrist pathologies from our population.

ABBREVIATIONS

CHR: Carpal height ratio
CHRr: Revised carpal height ratio

Conflicts of Interests: **None**

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How to cite this article:

Masarat Jehan, Nadeem Ali, Mohammad Saleem Itoo, Shaheen Shahdad, Altaf Ahmad Kawoosa. CARPAL HEIGHT RATIO IN KASHMIRI POPULATION: A STUDY OF ONE HUNDRED AND TWENTY WRIST RADIOGRAPHS. Int J Anat Res 2019;7(1.3):6314-6318. **DOI:** 10.16965/ijar.2019.108