RESEARCH ARTICLE

Correlation between Adult Height and Metacarpal Length Using Advanced Imaging Modalities

Pedro K. Beredjiklian, MD; Gregory G. Gallant, MD; Rick Tosti, MD; Moody Kwok, MD; Jeremiah A. Adams, BS; Daniel Fletcher, MD

Research performed at Rothman Orthopaedic Institute at Thomas Jefferson University, Philadelphia, PA, USA

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Abstract

Objectives: The primary objective of this study was to evaluate the correlation between height and metacarpal length in normal adults using computed tomographic (CT) scans. A secondary aim was to determine if differences exist between various finger metacarpals. We hypothesized a direct correlation between height and metacarpal length, with consistent proportions across different finger metacarpals.

Methods: This radiographic study analyzed 40 CT scans of skeletally mature adult patients. Measurements of the metacarpal lengths were taken using the Sectra IDS7 diagnostic imaging platform. Patient demographics, including age, sex, height, weight, and BMI, were collected. Differences between genders and among metacarpals were assessed using independent sample t-tests, while Pearson correlation coefficients determined the relationship between height and metacarpal length. Statistical significance was defined at $P<0.05$.

Results: The study population consisted of 28 men and 12 women, with an average age of 42.6 years. The mean heights and weights were 175.3 cm and 87.4 kg, respectively. The average lengths of the metacarpals were: index, 67.7 mm; long, 66.1 mm; ring, 58 mm; small, 52.3 mm. Pearson correlation coefficients between height and metacarpal lengths averaged 0.71, indicating a statistically significant positive correlation across all metacarpals. The index metacarpal most closely correlated with patient height.

Conclusion: Our findings confirm a significant positive correlation between height and metacarpal length, supporting the hypothesis of a direct relationship. These results suggest that height can be a useful predictor for metacarpal length, potentially aiding in the selection of orthopedic implants and surgical planning for metacarpal fractures. CT scans provide precise measurements, underscoring their value in assessing bony anatomy. Future studies with larger and more diverse populations are needed to validate these findings and explore potential sex-based differences in metacarpal dimensions.

Level of evidence: II

Keywords: Computerized tomographic scanning, Height, Length, Metacarpal

Introduction

Metacarpal bones are essential in grasping, manipulation, and load-bearing activities. Their anatomic configuration is influenced by genetic factors, environmental stimuli, and mechanical loading during growth and development. Metacarpals are susceptible to injury, and fractures account for almost one-fifth of upper extremity fractures.[1] There are several fixation options available for the treatment of these injuries, including pins, plates, wires, and screws. Knowledge of bony anatomy and available implants is vital for operative planning and proper fixation.[2]

Understanding of bony anatomic dimensions can be critical in selecting orthopaedic implants used for fixing bony injuries.[3] Specifically, appropriate implant sizing is necessary to decrease the incidence of implant related complications in the postoperative period.[4] While preoperative templates can provide a reasonable estimate of bony dimensions to help in choosing the appropriate implant, this approach may not be feasible in the treatment of traumatic injuries.

Corresponding Author: Pedro K. Beredjiklian, Rothman Orthopaedic Insitute at Thomas Jefferson University, Philadelphia, PA, USA

Email: pedro.beredjiklian@rothmanortho.com

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Most previous anthropometric studies of metacarpal bones have relied on measurements of cadaveric specimens from skeletal collections or plain x-ray studies.[5,6] Among these measurements, the length of the metacarpal bones may be of interest due to its potential association with overall body size and proportions. While previous studies have explored the relationship between height and skeletal dimensions, the specific correlation between height and metacarpal length remains unclear.[7] advanced imaging modalities, which can render a more accurate representation and dimensional analysis of bone size, have yet to be used.[8]

The goal of this study is to evaluate the correlation between height and metacarpal length of normal adults using computerized tomographic (CT) scans. A second aim is to determine whether differences are present between different finger metacarpals. We hypothesized there would be a direct correlation between height and metacarpal length, and that the proportions would not vary significantly between finger metacarpals.

Materials and Methods

This study is a radiographic evaluation of 40 computed tomography (CT) scans of the hands of skeletally mature adult patients. These data were obtained as part of a previous study comparing the size of metacarpals with commercially available headless compression screws.[3] these patients presented to our clinic between 2010 and 2018. Metacarpals with any evidence of previous fractures, implanted hardware, bone or soft tissue abnormalities, or incomplete CT sequences were excluded from the study. Patients whose demographic data was not available were also excluded from the study. Patients with a CT scan of the hand were included and reviewed.

Per the previous protocol and as published previously, all CT scans were measured using the Sectra IDS7 (Linköping, Sweden) diagnostic imaging platform.[3] this was set to a calibrated contrast and white balance and was reviewed by a fellowship-trained orthopaedic hand surgeon. The metacarpal length and midshaft in the coronal bone windows were measured by analyzing the CT scans of the index, long, ring, and small metacarpals. This measurement was made using the localizer function to determine the corresponding location of the isthmus on the coronal bone window. This distance was then normalized for each bone by dividing this distance by the metacarpal length.

Patient demographics, including age, sex, height, weight, and body mass index (BMI), were obtained from the electronic medical record.

Differences between genders and between metacarpals were analyzed using independent sample t-tests. Pearson correlation coefficients were used to establish concordance between values. Statistical significance was defined at $P<0.05$. Statistical analysis was performed using Microsoft Excel (Office Standard 2016, Redmond, Washington, United States).

Results

The study comprises 40 adult patients, with an average age of 42.6 years (range 17 to 88). There are 28 men and 12 women. The average height of the group is 175.3 cm (range 152 to 198), the average weight is 87.4 kg (range 47 to 149), and the average body mass index is 28.3 kg/m^2 (range 20-46).

The average lengths of the metacarpals were as follows: Index, 67.7 mm (range 59 to 76); long, 66.1 mm (range 54 to 74); Ring, 58 mm (range 48 to 66); Small, 52.3 mm (range 41 to 59).

Pearson correlation coefficients between height and metacarpal length averaged 0.71: index, 0.74; long, 0.72; ring, 0.66; small, 0.71 [Figure1]. All correlations were found to be statistically significant ($P<0.05$).

Discussion

Anthropometry, defined as the quantitative measurement of human body dimensions, is an important adjunct in various disciplines, including anthropology, biomechanics, and medicine.[5,9] These measurements are important tools for understanding human variation and its implications for various pathological processes.[10] These measurements, within an individual or as part of a population, can provide important information regarding nutritional status and environmental factors affecting health status.[11]

Among the many skeletal measurements utilized in anthropometric analysis, the length of the metacarpal bones has garnered interest due to its potential association with body size and proportions.[12] Understanding the correlation between height and metacarpal length may hold significant implications for elucidating human morphological variation, evolutionary adaptations, forensic analysis, and surgical treatment. Despite the recognized importance of skeletal dimensions in anthropometric studies, the specific relationship between height and metacarpal length remains poorly understood.[13]

Fractures of the metacarpal bones are commonplace, and account for approximately 18% of upper extremity fractures.[3] newer techniques and implants, such as headless compression screws, have improved the outcomes of treatment and facilitated earlier postoperative rehabilitation protocols. Understanding of bony anatomic dimensions is of substantial importance in selecting orthopaedic implants.[3] Often times, in the setting of trauma, a proper assessment of bony dimensions for surgical planning is not feasible in the preoperative period. Anatomic deformity due to displacement and comminution can significantly impair the ability for surgical preoperative templating. Based on the results of this study, it is possible that the use of the patient's height, used as a general indicator of metacarpal length, may help facilitate this process. Along with more accurate surgical planning comes the potential to minimize intraoperative adjustments, reduce surgery time, and lower complication rates. Additionally, this knowledge may aid in resource allocation by predicting implant needs based on patient demographics, support advanced biomechanical studies for surgical innovation, and assist in screening for developmental anomalies or fracture predispositions.

This study aimed to evaluate the correlation between height and metacarpal length in normal adult individuals using computed tomographic (CT) scans. Our findings revealed a significant positive correlation between height and metacarpal length across all finger metacarpals, with

Pearson coefficients averaging 0.71, indicating good to excellent correlation. All correlations were found to be statistically significant. The index metacarpal was the longest metacarpal and the one that most closely correlated with patient height. These results support our hypothesis that a direct relationship exists between height and metacarpal dimensions. The observed correlation underscores the potential utility of height as a predictor for metacarpal length, which may have implications for orthopedic implant sizing and surgical planning in treating metacarpal fractures.

CT scans allowed for precise and comprehensive measurements of metacarpal dimensions, providing a more accurate assessment than traditional anthropometric studies based on cadaveric specimens or plain radiographs.[14,15] By leveraging advanced imaging modalities, we could analyze multiple parameters, including metacarpal length and diameter, across different finger metacarpals. This detailed evaluation facilitated a thorough understanding of bony anatomy, which is crucial for selecting appropriate orthopedic implants and optimizing surgical outcomes.

Our study population consisted of skeletally mature adult patients, ensuring consistency in bone maturity, and minimizing confounding variables associated with growth and development. However, it is important to acknowledge the limitations of our study, including the relatively small sample size and the predominance of male participants. While gender differences were not observed in metacarpal length, the limited representation of female subjects may affect the generalizability of our findings to the broader population. Finally, the physiologic decrease in height with advanced age may limit the generalizability of these findings when assessing patient populations of different ages. Future studies with larger and more diverse cohorts are warranted to validate our results and explore potential sex-based differences in metacarpal dimensions.

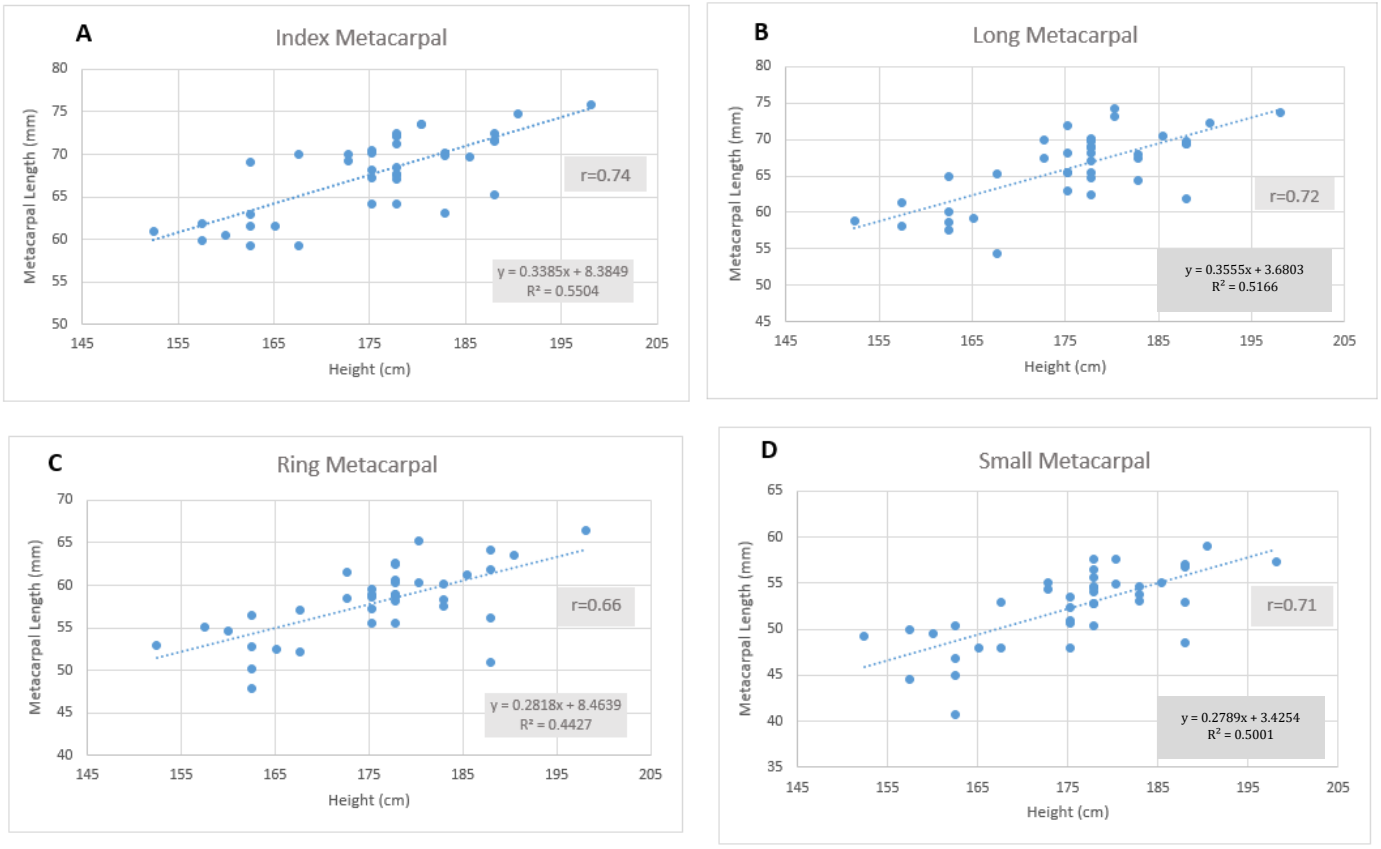

Figure 1. Correlation between index (a), long (b), ring (c), and small (d) metacarpal lengths and height

Conclusion

In conclusion, our study provides valuable insights into the relationship between height and metacarpal dimensions, highlighting the utility of CT imaging in assessing bony anatomy for orthopedic interventions. The positive correlation between height and metacarpal length underscores the potential clinical relevance of height as a predictive factor for implant sizing and surgical planning in managing metacarpal fractures.

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Authors Contribution:

Pedro K. Beredjiklian: Study conceptualization and design, Data collection, Data analysis, Writing – original draft, Writing – review and editing; Gregory G. Gallant: Contributed data, Writing – review and editing; Richard J. Tosti: Contributed data, Writing – review and editing; Moody Kwok: Contributed data, Writing – review and editing; Jeremiah A. Adams - Data Analysis, Writing – review and editing; Daniel Fletcher: Supervised study, Contributed data, Writing – review and editing; All authors reviewed the results and approved the final version of the manuscript.

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Pedro K. Beredjiklian MD [1]
Gregory G. Gallant MD [1]
Rick Tosti MD [1]
Moody Kwok MD [1]
Jeremiah A. Adams BS [1]
Daniel Fletcher MD [1]

1 Rothman Orthopaedic Insitute at Thomas Jefferson University, Philadelphia, PA, USA

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