

A STUDY OF PROPORTION OF HAND SEGMENTS IN A POPULATION OF CENTRAL INDIA**¹*Dr. H. S. Varma, ²Dr. Ashish Sirsikar and ³Dr. Nishant Gupta**¹Professor, Department of Orthopaedics, Netaji Subhash Chandra Bose Medical College, Jabalpur.²Assistant Professor, Department of Orthopaedics, Netaji Subhash Chandra Bose Medical College, Jabalpur.³PG Resident, Department of Orthopaedics, Netaji Subhash Chandra Bose Medical College, Jabalpur.***Corresponding Author: Dr. H. S. Varma**

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ABSTRACT

It has been generally accepted in medical literature that there is certain regularity in the proportion of hand segments. The eminent hand surgeon J. William Littler^[1] in 1973, proposed two mathematical relationships between the anatomic and functional geometry of the hand. Firstly, the motions of the tips of the fingers follow an equiangular spiral and second that the lengths of the phalanges follow a Fibonacci series. We studied the anterior-posterior X-Ray images of right and left hands of 200 adult patients from 19 to 60 years old without any bone pathology or deformities of the hand. For the index, middle and ring fingers the average PIP-DIP/ DIP-Tip ratio was 1.3. This approximates to a ratio for the distances PIP-DIP/DIP-Tip of 4:3. The PIP-DIP/ DIP-Tip distance for the little finger was also 1.3. The ratio of the distance from the metacarpophalangeal joint to the proximal interphalangeal joint (MCP-PIP) and the distance from PIP to phalangeal tip is 1:1 in all the fingers. The ratio of the distance from the PIP to the distal interphalangeal joint (PIP-DIP) and the distance from the DIP to the phalangeal tip (DIP-tip) is 1.3:1 for all the fingers. In other words, the ratios of the DIP-tip/PIP-DIP/MCP-PIP distances were 1:1.3:2.3 for all fingers.

KEYWORD: PIP - Proximal interphalangeal joint, DIP - Distal interphalangeal joint, MCP - Metacarpophalangeal joint.

INTRODUCTION

It has been generally accepted in medical literature that there is certain regularity in the proportion of hand segments. The first ever hypothesis was presented / published by the eminent hand surgeon J. William Littler^[1] in 1973, who proposed two mathematical relationships between the anatomic and functional geometry of the hand. Firstly, the motions of the tips of the fingers follow an equiangular spiral and second that the lengths of the phalanges follow a Fibonacci series. Although the first hypothesis has been experimentally supported the second one has conflicting evidence in the literature.^[3]

The Fibonacci series^[2], discovered in 1202 by the Italian Leonardo di Pisa, or Fibonacci, is a sequence of numbers for which, beginning with 0 and 1, the successive term is the sum of every two previous consecutive terms. The Fibonacci series begins 0, 1, 1, 2, 3, 5, 8, 13, 21, 34... Originally used to model rabbit reproduction, the Fibonacci series has proved useful in the modeling of biological and financial systems as well as in electronics and music. It is the most basic summative sequence.

AIMS AND OBJECTIVE

- To evaluate the ratio between all the three phalanges of every finger and all 5 metacarpals, and height of soft tissue on the tip of the fingers.
- To find a regular pattern of length correlations of phalanges with fingertip and metacarpals.
- To establish ratios of the phalanges and metacarpals and their correlation with the whole corresponding finger length including fingertip soft tissue length.
- To re-evaluate whether the proportions of finger segments follow the Fibonacci series.

METHODOLOGY

We studied the anterior-posterior X-Ray images of right and left hands of 200 adult patients from 19 to 60 years old without any bone pathology or deformities of the hand.

The length between the X-ray source and the sensor was kept constant in all cases. The resulting image was 100 % of the real studied anatomical region. We used a radiopaque ruler on every tenth patient and check its real length and the length on the resulting X-ray image to confirm the measurement accuracy. The explorative

targets were interarticular lengths of finger bony phalanges and metacarpals, soft tissues length at the finger tips, web heights, and the relative lengths of the segments between the web, the finger joints and the finger tip.



Fig. 1: APX-ray Image of hand with quantities measured.

RESULT

Table 1: Confidence Intervals For The Difference of The Proximal Phalanx From The Sum of The Middle And Distal Phalanges And The Difference of The Metacarpal From The Sum of The Middle And Proximal Phalanges.

Figure No.	(P3 + P2) - P1		(P2 + P1) - MC	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit
I	-5	-3.2	-24.9	-21.9
II	8.8	13.1	-23	-19.6
III	7.6	13.1	-16.9	-13.8
IV	10.3	14.5	-10.4	-8.1
V	6.3	9.8	-15.8	-13.8

P3, distal phalanx; P2, middle phalanx; P1, proximal phalanx; MC, metacarpal.

Zero is not contained in the 95% confidence interval for any of the relationships in any of the digits.

Table No. – 2: Confidence Interval for Ratios of Adjacent Bone Lengths.

	P2/P3		P1/P2		MC/P1	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit
I					*1.69	1.8
II	0.7	0.75	1.33	1.42	1.93	2.06
III	0.69	0.75	1.33	1.44	*1.61	1.74
IV	0.73	0.77	1.29	1.38	1.55	*1.65
V	0.66	0.71	1.4	1.52	1.71	1.83

P3, distal phalanx; P2, middle phalanx; P1, proximal phalanx; MC, metacarpal; Phi (Ø) 1.61803. *These quotients were the only ones contained in the 95% confidence interval.

DISCUSSION

- In our study we found out that there is a regular pattern of length correlations of phalanges with fingertip and metacarpals. Also that the bone lengths of the fingers do not follow the Fibonacci relationship, whereas the motion paths of the digits form an equiangular spiral.
- With the exception of the quotient of the metacarpal to the proximal phalanx of the second, third and fifth

finger, the ratio Phi is never contained in the 95% confidence interval.

CONCLUSION

- Our first aim was to evaluate the ratio between all the three phalanges of every finger and all 5 metacarpals, and height of soft tissue on the tip of the fingers. In our study we found out that the ratio

for the MCP-PIP/PIP-Tip distances approximates to 1 for all of the fingers of the human hand.

- For the index, middle and ring fingers the average PIP-DIP/ DIP-Tip ratio was 1.3. This approximates to a ratio for the distances PIP-DIP/DIP-Tip of 4:3. The PIP-DIP/ DIP-Tip distance for the little finger was also 1.3.
- Our second aim was to find a regular pattern of length correlations of phalanges with fingertip and metacarpals. In our data consisting of 200 individuals the ratio of the distance from the metacarpophalangeal joint to the proximal interphalangeal joint (MCP-PIP) and the distance from PIP to phalangeal tip is 1:1 in all the fingers. The ratio of the distance from the PIP to the distal interphalangeal joint (PIP-DIP) and the distance from the DIP to the phalangeal tip (DIP-tip) is 1.3:1 for all the fingers. In other words, the ratios of the DIP-tip/PIP-DIP/MCP-PIP distances were 1:1.3:2.3 for all fingers
- Our third aim was to re-evaluate whether the proportions of finger segments follow the Fibonacci series. In our study also we saw that zero was not included within the 95% confidence interval in any of the digits when subtracting the proximal phalangeal bone length from the sum of the distal and middle phalanges as well as for the difference of the metacarpal length to that of the sum of the middle and proximal phalanges ie: $(P3 + P2) - P1$ as well as $(P1+P2) - M$.

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