Original Article

MORPHOLOGY OF THE DISTAL HUMERUS IN HUMAN AND ITS CLINICAL SIGNIFICANCE

Atanas Katsarov,
Yordan Yordanov

Institute of Experimental Morphology and Anthropology with Museum Bulgarian Academy of Sciences, Sofia

Summary

Recent study is dedicated to a not so well studied part of the human skeleton the distal end of the human humerus. The research was carried out in the period 2001 2005. We made detailed medical anthropologic characteristic of the distal end of the human humerus by measuring 26 linear signs, 10 angular signs, 3 derivative and 20 indexes. The data of so created metric tables could be used in clinical orthopedic & trauma practice.

Key words: morphology, distal, humerus, human, clinical.

Introduction

The investigation of the different anthropometric signs and its variability during the ontogenetic development is a problem of high priority in the modern anthropology [1]. Knowing the morphology of the distal part of the human humerus is of a great importance for the clinical practice. Fractures and injuries in the area of the elbow joint are often severe and results are still not satisfying.

Solving of the problem is difficult because of the necessity of simultaneous work and coordination of specialists from different fields of the Medicine and Anthropology. This supposes the possession of profound knowledge and perfect coordination between the investigators, having in mind that the fractures around the elbow joint are 7% from the fractures of all bones [2].

The use of ultra structural methods of diagnostics made possible the discovery and etiologic classification of many diseases which were only known pathogenetically.The distal end of the human humerus is not so well studied than the other parts of the human skeleton.

The actuality of the problem is determined of the fact of wider entering of electronic devices and computer assisted technologies I in medicine. This results in creation of real or virtual models with unified values of the anthropometric data.

Creation of different models of the bone skeleton attracts the attention of many specialists in different field of science because of the introduction of the new technologies, good final results and the pursuit of maximum approach to the human biology [3].

Materials and Methods

Our work ranges over analysis and valuation of the data collected after the measuring of 138 bones (63 - men's, 75-

Corresponding Author:
Atanas Katsarov
Institute of Experimental Morphology and Anthropology with Museum
Bulgarian Academy of Sciences
73, Tzarigradsko shosse str.
Sofia, 1113
Bulgaria

women's) from cadavers. We made detailed medical anthropologic characteristic of the distal end of the human humerus. The steps we followed were to create a program for total and detailed anthropologic characterization of the distal humerus; index characterization; studying of the metric variability of the anthropologic signs and the distribution by sex and lateralization; creating of tables containing metric data appropriate for application in practice.

The practical work consisted of measuring 26 linear signs - 7 known and 19 new; 10 angular signs - 3 known, 4 new and 3 derivative. The twenty indexes that we describe were calculated on the basis of the measured signs. The collected data was calculated by the means of descriptive statistics, t-tests, differentiation tests, ANOVA, cluster analysis, step discriminative analysis, SigmaStat, SigmaPlot and STATISTICA for Windows.

Results

Quantitative and qualitative anthropologic characteristic of the human skeleton is done by evaluation of the anthropometric signs. According to that we could divide them in two groups - qualitative (metric) signs and quantitative (description) signs.

In our study we reveal the results of investigation of bone material from cadavers. The anthropometric signs are compared by sex and lateralization (left-right). Coefficients are reliable at $p<0.01$.

Anthropometric signs of the distal humerus

Common linear signs

EL - Epiphyseal Length (mm).
Dap - Antero - posterior diameter (mm). It is measured at the level of the proximal end of the olecranon fossa.
Dml - Medio lateral diameter (mm) - measured at the level of the proximal end of the olecranon fossa.
TcW - Transcondylar Width is the biggest width measured over the two epicondyles.
LiF - lamina between olecranon fossa and coronoidal fossa (mm).

Coronoid fossa metric signs

FcW - Width (mm).
FcH - Height (mm).
FcD - Depth (mm).

Metric signs of the humeral trochlea

TL - Length (mm).
MPT - Medial trochlear ridge length (mm).
LPT - Lateral trochlear ridge length (mm).
TW1 - trochlear width (mm) - measured at the level of medial ridge of the trochlea.
TW2 - trochlear width (mm) - measured at the level of middle of the trochlea.
TW3 - trochlear width (mm) - measured at the level of lateral ridge of the trochlea.

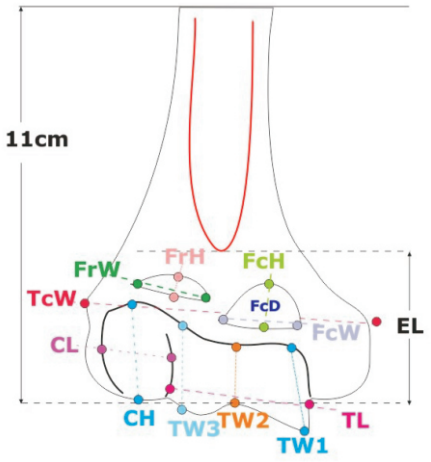

Fig. 1. Metric signs front view

Metric signs of the capitulum humeri

CL - length of the capitulum (mm).
CH - height of the capitulum (mm).
Cpd - front dorsal diameter of the capitulum (mm).

Medial column metric signs

MCW - width of the medial column (mm).
MCL - length of the medial column (mm).
MCap - front dorsal diameter of the medial column (mm). It is measured at the level of the middle of the olecranon fossa.

Lateral column metric signs

LCW - width of the lateral column (mm).
LCL - length of the lateral column (mm).
LCap - front dorsal diameter of the lateral column (mm). It is measured at the level of the middle of the olecranon fossa.

Olecranon fossa metric signs

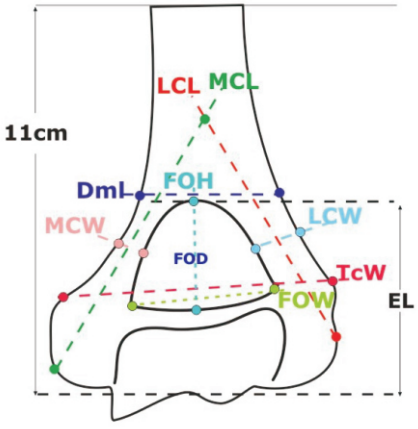

Fig. 2. Metric signs dorsal view

FOW - width of the olecranon fossa (mm).
FOH - height of the olecranon fossa (mm).
FOD - depth of the olecranon fossa (mm).

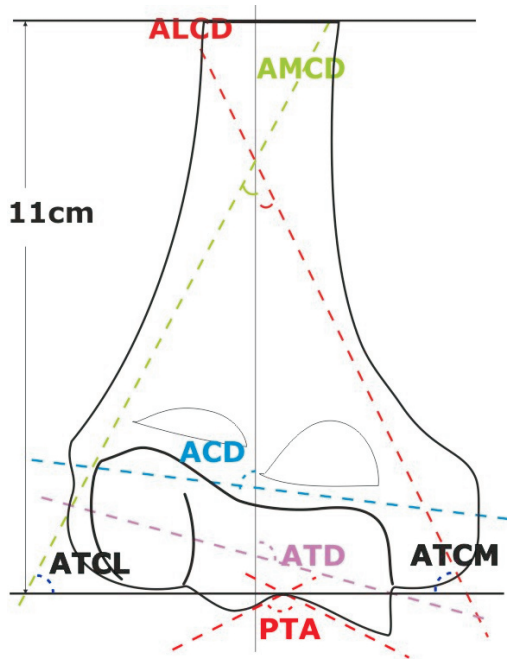

Fig. 3. Angular signs front view

Angular signs

ATD - trochlear dyaphiseal angle. Measured in degrees.
ACD - condyle-dyaphiseal angle. Measured in degrees.
ALCD - lateral condyle dyaphiseal angle. Measured in degrees.
AMCD medial condyle - dyaphiseal angle. Measured in degrees.
ATCM - it is an auxiliary angle. Use in determination of AMCD.
ATCL - it is an auxiliary angle. Use in determination of ALCD.
AvCM - angle of medial column anteversion.
AvCL - angle of lateral column anteversion.
ASAA - axial angle of the articulate surface.
PTA - (Primary Trochlear Angle) - it is measured between the two ridges of the trochlea.
We measured 6 signs for the trochlea. Schematically presented its lateral and medial ridges are parallel. After measuring of TW1, TW3 and TL, we input the data in created from us computer program which calculates the angle PTA (Table 1).

Table 1. Mean value (in degrees) of angular sings

ANGULAR SIGN	VALUE ( )	VALUE ( )
ATD	93.79	93.23
ACD	84.63	84.45
ALCD	22.27	20.19
AMCD	43.08	42.29
AvCM	174.59	174.49
AvCL	126.49	124.83
ASAA	5.54	5.39

Descriptive signs

We created 4 **descriptive** signs with its categories. They describe the shape and the size of the distal end of the humerus and have two values positive (+) and negative (-).
Shape: isosceles triangle (+), equilateral triangle
Size
Width
Massiveness: (+) and (-).

Anatomic variations

All the bones were checked for anatomic variations as follows:
Olecranon fossa perforation
Struther's ligament presence
Supracondylar process presence
We used SigmaStat, SigmaPlot и STATISTICA for results analysis and graphical presentation.

Morphometrical indexes

We created 20 anthropometrical indexes presented in two groups common and special, coded with three sign abbreviation.

Common indexes

Thikness-width index DSI = Dap / Dml.
Width-condylar index DTI = Dml / TcW.
Thickness-width index STI = Dap / TcW.

Special indexes

Capitellar - trochlear indexes:

Table 2. Mean value (mm) of common linear sings

Metric sign	Dap	Dml	FcW	FcH	FcD	TcW	LiF	TL	MPT	LPT	TW1	TW2	
Mean value	17.21	39.56	13.76	11.40	3.80	62.45	2.16	25.15	14.21	12.57	26.39	17.63	
Metric sign	**TW3**	**CL**	**CH**	**Cpd**	**MCap**	**MCL**	**MCW**	**LCap**	**LCL**	**LCW**	**FOW**	**FOH**	**FOD**
Mean value	24.56	18.92	17.40	21.92	11.13	57.45	13.56	13.26	54.27	17.84	22.83	18.02	10.59

Common length index - TLI = CTC / TcW.
Capitellar-trochlear index - CTI = CL / TL.
Capitelar-complex index - CCI = CL / CTC.
Trochlear-complex index - TCI = TL / CTC.
Trochlear indexes
Height-length index -HTI = TL / TH.
Medial ridge index - MPI = MPT / TL.
Lateral ridge index - LPI = LPT / TL.
Height-Length index of the capitelum - HCI = CL / CH.
Medial column indexes
Total width index - MWI = MCW / Dml.
Length thickness index - MLI = MCW / MCL.
Total length index - MTI = MCL / TcW.
Lateral column indexes
Total width index - LWI = LCW / Dml/ Dml.
Length-thickness index - LLI = LCW / LCL.
Total length index - LTI = LCL / TcW..
Coronoid fossa index - FCI = FcH / FcW.
Olecranon fossa indexes
Total transverse index - TOI = FOW / TcW.
Height thickness index - HWI = FOH / FOW.

Table 3. Mean value of indexes. FD female right, FL female left, MD male right, ML male left.

	DSI	DTI	STI	CT	TLI	CTI	CCI	TCI	HTI	MPI	LPI	HCI	MWI	MLI	MTI	LWI	LLI	LTI	FCI	TOI	HWI
FD	0.31	0.40	0.20	28.1	0.50	0.50	0.30	0.40	0.70	0.40	0.40	0.70	0.20	0.20	0.60	0.30	0.20	0.60	0.70	0.30	0.60
FL	0.30	0.40	0.20	26.8	0.50	0.50	0.30	0.40	0.60	0.40	0.40	0.70	0.20	0.10	0.60	0.30	0.20	0.60	0.70	0.30	0.50
MD	0.28	0.40	0.20	24.9	0.40	0.50	0.30	0.40	0.60	0.40	0.30	0.60	0.20	0.10	0.60	0.30	0.20	0.50	0.60	0.20	0.50
ML	0.27	0.40	0.20	23.9	0.40	0.40	0.30	0.40	0.60	0.30	0.30	0.60	0.20	0.10	0.50	0.30	0.20	0.50	0.60	0.20	0.50

We believe that there is a direct **correlation** between the total length of the trochlea TL and the value of the angle PTA. As bigger is the value of PTA bigger is the legth of the troclhlea. The sign is derivative and is calculated by our own computer program after input of the values of TW1, TW3, MPT и LPT.

Discussion

The problem for the morphometric characteristic of the distal humerus in human showed significant complexity, inexhaustibility and actuality [2, 4].

The data of such studies are **important** not only for the physical anthropology but for the medical anthropology which is a basic source for the metric characteristic data of different human parts and organs.

It is normal not to **expect** big changes in bone morphology of the recent human in parallel with his ancestors because the structure of the bones, as a result of the evolution process, responds to their function [5].

We think that our study will provide valuable material for joint replacement in the elbow joint, for reconstructive operations in orthopaedics and even for modern transplatology.

The data of created metric tables could be used in clinical orthopedic & trauma practice - prosthesis construction and implantation, reconstructive surgery, bone plastic surgery, etc., of the elbow joint.

Conclusions

As a result of our study we can say that it is the most detailed and full investigation of the distal humerus made for the first time in Bulgarian population [6]. For the first time in anthropologic practice 26 signs and 20 indexes are presented and all the bones are identified by sex and age. We created original computer method for calculation of the angular signs. The data of our study confirm the bicolumn theory of the distal humeral structure and as an addition we suggest the capitulum humeri to be included in it [7]. Our observations showed that the existing of olecranon fossa fenestration does not extend the volume of extension of the elbow joint because not the tip of the olecranon comes to the bottom of the fossa but its articular surface comes to the walls of the olecranon fossa.

The data of so created original metric tables could be used in endoprosthetic construction and in the clinical orthopaedic trauma practice - prosthetic replacement, reconstructive operations, bone plasty, etc. in the area of the elbow joint.

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