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MORPHOLOGICAL PECULIARITIES OF CERTAIN FEMORAL PORTIONS

***Key words**: morphological peculiarities, volume-mass parameters, femur.*

***Abstract**. The principal volume-mass parameters characterizing morphological peculiarities of various femoral portions have been examined. The peculiarities of the volume parameters distribution of the hard matrix pores and water, organic and mineral parts, their density, general density of the bone and mineral part mass in the samples from various surfaces of the femur in its superior, middle and inferior thirds have been studied. The data obtained will enable to present a comprehensive characteristic of the examined bone in all its circumference and length, and to carry out further examination of their influence upon the regularities to form morphological signs of a fracture surface of the tubular bone in the moment of its destruction (traumatic lesion) in forensic medicine.*

Introduction

More and more contemporary researchers draw their attention to biology and function of the osseous tissue, its organization on the microscopic level, its nature of rigidity, elasticity and solidity, especially to the age dynamic of the osseous tissue mineral content, the influence of its main constituents upon the peculiarities of destructive process etc. [1, 2, 4, 5].

An increased interest of experts in forensic medicine to structural-functional peculiarities of separate human bones is quite natural, as a reliable detection of the mechanism of bone fractures includes examination of all their morphological elements considering the composition of the bone, its internal structure, peculiarities of microscopic architectonics and distribution of the volume-mass parameters [3, 6].

Objectives

To study morphological peculiarities of certain femoral portions in order to present a comprehensive characteristic of the examined bone in all its circumference and length, examine their influence upon the regularities to form morphological signs of a fracture surface of the tubular bone in the moment of its destruction. The data obtained will enable to present more reliable and substantiated results to investigatory powers while prosecuting inquiry in case of injuries of the long bones of the lower extremities.

Materials and methods

192 samples of various femoral portions removed from biological male and female mannequins at the age from 24 to 60.

The cases of diseases and injuries of the locomotive system, septic complications, comorbid pathology of the osseous system, visual abnormalities and references concerning various diseases and frequent skeletal injuries in anamnesis were not included in the group.

First of all, circular (on all circumference) 0,8-1,0cm thick articles (disks) from the superior, middle and inferior thirds of the thoroughly cleaned long bones of the lower extremity (the femoral bone, major and minor tibiae) were prepared by means of transverse cutting. Then, by means of longitudinal and transverse cutting one sample from the anterior, posterior, medial and lateral surfaces of every bone (per 12 samples from each bone) was made.

General volume of every sample V_1 was determined by means of rotary calibrated tubes, and by means of analytical balance their mass before and after filling them by orthoxylole, rotation, drying, baking of organic substance in the muffler was measured, thus getting the corresponding masses m and m^1.

The data obtained were calculated by means of a complex of formulas, in this way receiving a number of volume-mass parameters: the volume of the hard matrix pores (V_p) and water (V_w), the volume of organic (V_o) and mineral portion (V_m), the density of organic (p_o) and mineral portion (p_m) of every sample, general density (p_g) and the mass of mineral portion (M_m).

Results and discussion

The results obtained are presented in the following tables.

The data analysis from the Table 1 shows that the smallest values of the volume of the hard matrix pores are found on the medial surface in all the thirds

Table 1

Volume of the hard matrix pores and water in the samples of the femoral bone (N = 192)

Femoral bone, surface		Volume of the hard matrix pores (V_p)				Water volume in the hard matrix (V_w)			
		M±m	Mini-mum	Maxi-mum	S.D.	M±m	Mini-mum	Maxi-mum	S.D.
Upper third	Anterior	0,045± 0,0050	0,025	0,072	0,0199	0,003± 0,0006	0,001	0,006	0,0022
	Posterior	0,063± 0,0061	0,028	0,088	0,0245	0,006± 0,0010	0,001	0,010	0,0040
	Medial	0,024± 0,0022	0,015	0,036	0,0089	0,001± 0,0001	0,001	0,002	0,0005
	Lateral	0,045± 0,0057	0,014	0,071	0,0228	0,004± 0,0007	0,001	0,007	0,0028
Medial third	Anterior	0,051± 0,0071	0,022	0,091	0,0282	0,002± 0,0003	0,001	0,004	0,0012
	Posterior	0,031± 0,0024	0,023	0,042	0,0095	0,002± 0,0003	0,001	0,003	0,0010
	Medial	0,013± 0,0004	0,011	0,016	0,0014	0,001± 0,0010	0,001	0,001	0,0011
	Lateral	0,055± 0,0114	0,011	0,106	0,0454	0,003± 0,0006	0,001	0,006	0,0026
Lower third	Anterior	0,098± 0,0018	0,088	0,104	0,0070	0,009± 0,0001	0,009	0,010	0,0005
	Posterior	0,098± 0,0110	0,026	0,131	0,0439	0,013± 0,0016	0,002	0,017	0,0064
	Medial	0,055± 0,0049	0,032	0,077	0,0196	0,004± 0,0003	0,002	0,005	0,0013
	Lateral	0,109± 0,0087	0,079	0,148	0,0347	0,017± 0,0025	0,007	0,028	0,0100

Table 2

Volume of organic and mineral portion in the samples of the femoral bone (N = 192)

Femoral bone, surface		Volume of organic portion (V_o)				Volume of mineral portion (V_m)			
		M±m	Mini-mum	Maxi-mum	S.D.	M±m	Mini-mum	Maxi-mum	S.D.
Upper third	Anterior	0,335± 0,0225	0,273	0,464	0,0900	0,442± 0,0410	0,275	0,644	0,1639
	Posterior	0,282± 0,0183	0,184	0,373	0,0732	0,376± 0,0232	0,226	0,459	0,0927
	Medial	0,356± 0,0266	0,190	0,480	0,1062	0,441± 0,0398	0,322	0,673	0,1593
	Lateral	0,337± 0,0295	0,165	0,472	0,1182	0,520± 0,0199	0,388	0,577	0,0794
Medial third	Anterior	0,327± 0,0232	0,192	0,434	0,0930	0,417± 0,0176	0,363	0,519	0,0704
	Posterior	0,381± 0,0157	0,277	0,426	0,0628	0,502± 0,0216	0,395	0,593	0,0863
	Medial	0,265± 0,0157	0,160	0,302	0,0628	0,340± 0,0073	0,293	0,367	0,0292
	Lateral	0,287± 0,0176	0,170	0,336	0,0704	0,504± 0,0470	0,276	0,703	0,1878
Lower third	Anterior	0,173± 0,0137	0,127	0,251	0,0549	0,422± 0,0114	0,390	0,488	0,0457
	Posterior	0,197± 0,0095	0,138	0,236	0,0378	0,485± 0,0216	0,404	0,608	0,0866
	Medial	0,189± 0,0093	0,132	0,222	0,0371	0,380± 0,0105	0,340	0,439	0,0420
	Lateral	0,177± 0,0098	0,113	0,206	0,0392	0,467± 0,0043	0,440	0,483	0,0172

Table 3

Density of organic and mineral portion in the samples of the femoral bone (N = 192)

Femoral bone, surface		Density of organic portion (p_o), n=192				Density of mineral portion (p_m), n=192			
		M±m	Mini-mum	Maxi-mum	S.D.	M±m	Mini-mum	Maxi-mum	S.D.
Upper third	Anterior	1,238± 0,0123	1,204	1,320	0,0494	2,488± 0,1439	1,805	3,156	0,5755
	Posterior	1,191± 0,0154	1,089	1,245	0,0615	1,997± 0,0863	1,433	2,359	0,3452
	Medial	1,233± 0,0260	1,168	1,407	0,1039	2,668± 0,2189	1,790	3,668	0,8755
	Lateral	1,323± 0,0408	1,107	1,477	0,1631	2,077± 0,0833	1,502	2,293	0,3331
Medial third	Anterior	1,321± 0,0338	1,129	1,430	0,1352	2,408± 0,1089	1,723	2,835	0,4358
	Posterior	1,206± 0,0198	1,105	1,284	0,0791	2,354± 0,0369	2,094	2,470	0,1476
	Medial	1,187± 0,0149	1,102	1,230	0,0594	2,511± 0,0871	1,998	2,892	0,3483
	Lateral	1,223± 0,0216	1,105	1,302	0,0863	1,970± 0,0665	1,627	2,265	0,2661
Lower third	Anterior	1,752± 0,0716	1,394	2,039	0,2863	1,593± 0,0647	1,038	1,825	0,2588
	Posterior	1,493± 0,0362	1,258	1,625	0,1450	1,742± 0,0615	1,409	2,028	0,2460
	Medial	1,300± 0,0118	1,221	1,331	0,0470	1,755± 0,1072	1,252	2,255	0,4288
	Lateral	1,606± 0,0343	1,495	1,831	0,1370	1,545± 0,0683	1,097	1,773	0,2731

Table 4

General density of the bone and mass of mineral portion in the samples of the femoral bone (N = 192)

Femoral bone, surface		General density of the bone (p_g), n=192				Mass of mineral portion (M_m), n=192			
		M±m	Mini-mum	Maxi-mum	S.D.	M±m	Mini-mum	Maxi-mum	S.D.
Upper third	Anterior	1,949± 0,0677	1,627	2,262	0,2710	63,135± 0,2104	61,919	64,344	0,8416
	Posterior	1,632± 0,0622	1,269	1,936	0,2489	60,580± 0,6725	55,867	63,206	2,6900
	Medial	2,040± 0,0949	1,677	2,475	0,3797	63,142± 0,3386	61,365	64,871	1,3545
	Lateral	1,802± 0,0477	1,480	1,959	0,1907	62,212± 0,0896	61,486	62,634	0,3586
Medial third	Anterior	1,998± 0,0696	1,608	2,333	0,2784	61,868± 0,3117	59,940	63,660	1,2467
	Posterior	1,928± 0,0188	1,800	2,002	0,0752	63,513± 0,0558	63,011	63,851	0,2232
	Medial	1,987± 0,0437	1,750	2,187	0,1747	63,983± 0,1265	63,219	64,664	0,5061
	Lateral	1,729± 0,0327	1,556	1,892	0,1307	63,334± 0,0955	62,734	63,848	0,3819
Lower third	Anterior	1,506± 0,0573	1,095	1,682	0,2291	58,762± 1,1933	50,519	62,876	4,7731
	Posterior	1,541± 0,0282	1,374	1,669	0,1127	63,775± 0,2578	62,326	65,094	1,0312
	Medial	1,560± 0,0663	1,225	1,862	0,2654	63,010± 0,3221	61,633	64,793	1,2884
	Lateral	1,404± 0,0381	1,172	1,585	0,1525	62,083± 0,4415	58,924	63,807	1,7660

of the femoral bone (in 2-2,5 times less as compared with other surfaces). Increased V_p value by the length of the bone from its upper and lower thirds are also found, where their maximal values are seen.

Similar tendency is observed in the osseous samples of the femoral bone by the results of the analysis of water volume. Thus, in all the thirds of the femoral bone the smallest values are found on the medial surface, which are in 3-6 times less than those on the posterior and lateral surfaces. At the same time, increased V_w value by the length of the bone from the medial to upper and lower thirds (in 3-4 times) is found, where maximal values are seen.

A comparative analysis of the data contained in Table 2 is indicative of minimal values of V_o on the posterior surface and their prevalence (in 0,8 times) on the rest of surfaces of the upper third of the femoral bone; in the medial third of the femoral bone V_o values on the anterior and posterior surfaces prevail over the medial and lateral ones, and in the lower third there is a mild prevalence of V_o values on the posterior and medial surfaces as compared with the anterior and lateral ones. A gradual increase of V_o values in the direction from lower to upper third of the bone if found.

According to the comparative analysis of V_m values in this table, their minimal values in the upper third of the femoral bone are found on the posterior surface, maximal ones – on the lateral surface, and intermediate – on the anterior and medial surfaces of the bone; in the medial and lower thirds of the femoral bone minimal V_m values are localized on the medial surface, maximal ones –on the posterior and lateral surfaces, and intermediate – on the anterior surface of the bone. Increased V_m values are found in the direction from the lower to medial and upper thirds.

The analysis of p_o values from Table 3 shows that its minimal values are found in the upper third of the femoral bone on the posterior surface, maximal ones – on the lateral surface, and intermediate are found on the anterior and medial surfaces of the bone. In the medial and lower thirds of the femoral bone minimal values are found on the medial surface, maximal ones – on the anterior one, and intermediate values – on the posterior and lateral surfaces of the bone. At the same time gradual increase of p_o values are found on almost all the surfaces of the bone in the direction from the upper to lower third of the femur.

The data analysis in the same Table 3 detects the smallest p_m values in the upper third of the femoral bone on the posterior surface, and the largest ones – on the medial surface, and intermediate ones – on the anterior and lateral surfaces of the bone. p_m values in the medial and lower thirds of the bone are the smallest on the lateral surface, the largest – on the medial one, and intermediate - on the medial and posterior surfaces of the bone. General increase of p_m values in the direction from the lower to upper third of the bone is found.

According to the analysis of general density of the bone (Table 4) the data obtained show that p_g values are minimal on the posterior surface in the upper third (in the medial and lower thirds – on the lateral surface), they are maximal on the medial surface, and intermediate – on the anterior and lateral surfaces of the femur. p_m values increase on the anterior and posterior surfaces of the femur from the lower and upper thirds to the medial one, and on the medial and lateral surfaces – from the lower to upper third of the femoral bone.

Analyzed values of the Table 4 of the mass of mineral portion of the femoral samples are indicative of the fact that in the upper third of the bone minimal M_m values are found on the posterior surface, maximal – on the medial one, intermediate – on the anterior and lateral surfaces of the femur. In the medial and lower thirds of the bone minimal values are found on the anterior surface, intermediate ones are on the remaining surfaces of the bone with a little difference between them. Pronounced fluctuations of the values by the bone length are not found, besides their gradual increase in the direction of the upper third along the anterior surface of the femur.

Conclusions

1. The results obtained enabled to present comprehensive characteristic of the structural-functional peculiarities of the femur by the distribution of their main morphological constituents.

2. In the upper third of the femoral bone minimal values of the volume of the hard matrix pores and water are found on the medial surface, the volumes of organic and mineral portion of the samples, their density, general density of the bone and mass of its mineral portion are found on the posterior surface with maximal values on the medial and lateral surfaces.

3. In the medial third of the femur minimal values of the volume of the hard matrix pores and water are found on the medial surface, the volumes of organic and mineral portions on the anterior and posterior surfaces prevail over the medial one, where their minimal values are found, the parameters of the organic portion density are maximal on the anterior surface, they are minimal on the medial surface; mineral portion density is maximal on the medial surface, and minimal on the lateral one with the smallest values of general density on the lateral surface and mineral portion mass on the anterior surface of the femoral bone.

Perspectives of further investigation

The parameters obtained will enable to examine their influence upon the regularities of formation of the morphological signs of the fracture surface of the tubular bone in the moment of its traumatic injury in forensic medicine, and present more reliable and substantiated results to investigatory powers while prosecuting inquiry in case of injuries of the long bones of the lower extremities.

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МОРФОЛОГИЧЕСКИЕ ОСОБЕННОСТИ ОТДЕЛЬНЫХ ОТДЕЛОВ БЕДРЕННОЙ КОСТИ

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Резюме. Исследовано основные объемно-массовые показатели характеризирующие морфологические особенности разных отделов бедренной кости. Изучено особенности распределения показателей объемов пор твердого матрикса и воды, органической и минеральной части, их плотности, общей плотности кости и массы минеральной части в образцах с разных поверхностей бедра у его верхней, средней и нижней трети. Полученные значения позволят дать всестороннюю характеристику исследованной кости по всей ее окружности и длине, а в дальнейшем, исследовать их влияние на закономерности формирования морфологических признаков плоскости излома трубчатой кости в момент ее разрушения (травматического воздействия) в судебно-медицинской практике.

Ключевые слова: морфологические особенности, объемно-массовые показатели, бедренная кость.

МОРФОЛОГІЧНІ ОСОБЛИВОСТІ ОКРЕМИХ ВІДДІЛІВ СТЕГНОВОЇ КІСТКИ

І.Г.Савка

Резюме. Досліджено основні об’ємно-масові показники, що характеризують структурно-функціональні особливості різних відділів стегнової кістки. Вивчено особливості розподілу показників об’ємів пор твердого матрикса і води, органічної та мінеральної частин, їх густини, загальної густини кістки і маси мінеральної частини в зразках із різних поверхонь стегна в його верхній, середній та нижній третинах. Отримані значення дозволять всебічно охарактерізувати досліджувану кістку по всій її окружності та довжині, а в подальшому дослідити їх вплив на закономірності формування морфологічних ознак площини перелому трубчастої кістки у момент її руйнації (травматичного ушкодження) в судово-медичній практиці.

Ключові слова: морфологічні особливості, об’ємно-масові показники, стегнова кістка.

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