Anisotropy of Child Cortical Fibula Bone for Seven Different Children Ages and Adult Tibia Bone

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ABSTRACT

The norm of elastic constant tensor and the norms of the irreducible parts of the elastic constants of the child cortical fibula bone for seven different children ages and adult tibia bone are calculated. The relation of the scalar parts norms and the other parts norms and the anisotropy of these bones is presented. The norm ratios are used as a criterion to present the anisotropy degree of the properties of these.

Keywords : Child Cortical Bone, Fibula Bone, Tibia Bone, Norm, Anisotropy, Elastic Constants, and Irreducible parts.

I. INTRODUCTION

The decomposition procedure and the decomposition of elastic constant tensor is given in [1], also the definition of norm concept and the norm ratios and the relationship between the anisotropy and the norm ratios are given in [1]. As the ratio N_s/N becomes close to one the material becomes more isotropic, and as the sum of N_d/N and N_n/N becomes close to one the material becomes more anisotropic as explained in [1-6].

II. METHODS AND MATERIAL

Data and Calculations

Table 1. Elastic constants in GPa, for seven child fibula samples, mean elastic constants, and the elastic constants of adult Tibia, are given below [7, 8].

| Age and Type of Specimens	c_{11}	c_{22}	c_{33}	c_{44}	c_{55}	c_{66}	c_{12}	c_{13}	c_{23}
9 years old	16.86	16.25	24.40	4.21	4.18	3.19	10.18	11.15	10.28
11 years old	16.50	16.30	24.50	4.20	4.10	3.20	10.00	10.50	10.40
13 years old	16.59	16.14	25.06	3.99	4.19	3.06	10.14	10.50	10.19
14 years old	16.99	16.08	24.47	4.10	4.30	3.10	10.06	10.86	10.32
15 years old	16.85	16.12	24.16	4.17	4.09	3.21	10.50	10.49	10.47
16 years old	16.79	16.06	24.20	4.12	4.16	3.14	9.84	10.42	10.09
18 years old	16.51	16.37	24.53	4.22	4.09	3.14	10.24	10.79	10.13
Mean Child fibula	16.73	16.19	24.47	4.14	4.16	3.15	10.14	10.67	10.26
Adult Tibia	14.79	14.79	26.64	5.52	5.52	3.65	7.49	8.31	8.31

By using table 1, and the decomposition of the elastic constant tensor and the norm concept, the norms and the norm ratios of the given bones can be calculated as in the following table.

Table 2. The norms and norm ratios (the isotropy degree) of the given bones.

Age and Type of Specimens	N_s	N_d	N_n	N	N_s/N	N_d/N	N_n/N	Sum of N_d/N and N_n/N
9 years old	42.41816	6.347901	1.074899	**42.90398**	0.988677	0.147956	0.025054	0.17301
11 years old	41.92147	6.42098	1.30942	42.43057	0.988002	0.151329	0.03086	0.182189
13 years old	42.01641	6.823359	1.689884	42.60039	0.986292	0.160171	0.039668	**0.19984**
14 years old	42.20495	6.440575	1.178207	42.7098	0.98818	0.150799	0.027586	0.178385
15 years old	42.164	5.974899	1.274085	42.6043	0.989666	0.140242	0.029905	**0.170147**
16 years old	41.49987	6.221794	1.364903	**41.98587**	0.988425	0.148188	0.032509	0.180696
18 years old	42.09924	6.396903	1.329137	42.6032	0.988171	0.150151	0.031198	0.181349
Mean Child fibula	43.20147	5.764342	2.078368	43.63387	**0.99009**	0.132107	0.047632	**0.179739**
Adult Tibia	38.67415	9.639066	1.049383	39.87107	**0.96998**	0.241756	0.026319	**0.268075**
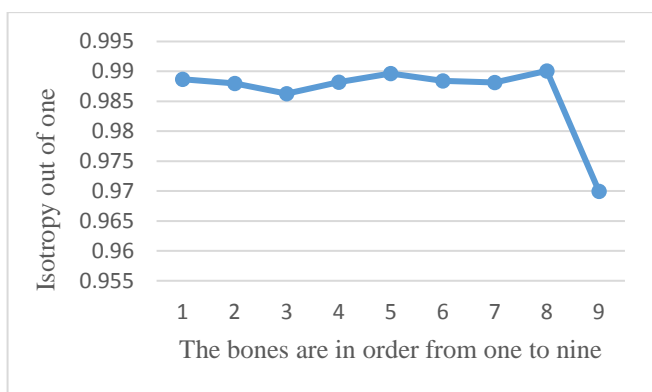
Graph 1. Isotropy Degree.
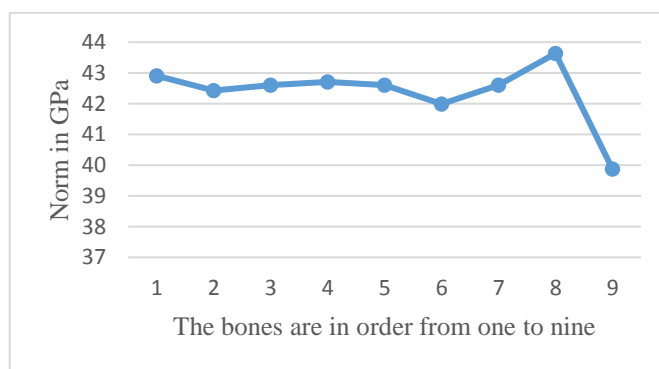
Graph 3. Elastically Srong
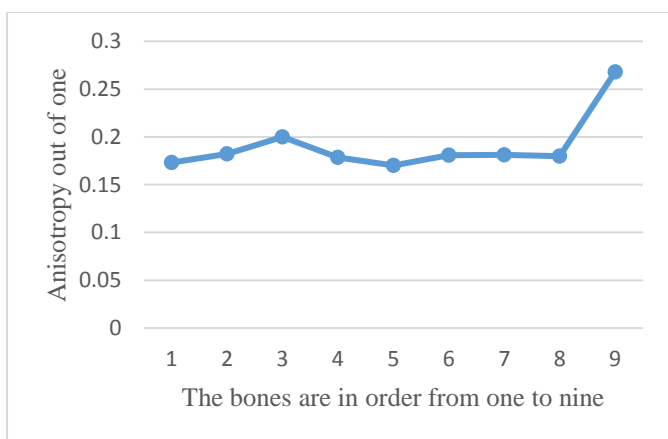
Graph 2. Anisotropy Degree.

III.CONCLUSION

From table 2 and the Graphs (Graph 1 to Graph 2), and analyzing the ratio N_s/N for different children ages we can conclude that 15 years old fibula bone is the most isotropic fibula bone with the highest value of N_s/N (0.989666) and with the lowest sum value of N_d/N and N_n/N (0.170147) and 13 years old fibula bone is the most anisotropic fibula bone with the highest sum value of N_d/N and N_n/N (**0.19984**) and with the lowest value of N_s/N (0.986292), and if we compare the mean of the fibula bones of these seven different children ages with the adult tibia bone we can note that the mean of the fibula bone with value of N_s/N (0.99009) and with sum value of N_d/N and N_n/N (0.179739) is more isotropic and less anisotropic than the adult tibia bone with value of N_s/N (0.96998)

and with sum value of N_d/N and N_n/N (0.268075) and the adult tibia bone is less isotropic and more anisotropic than the seven fibula bones of different children ages. And also among the seven fibula bones of different children ages the elastically strongest fibula bone is the nine years old which has the highest value of. N (42.90398), and the elastically lowest strongest is 16 years old, which has the lowest value of N (41.98587) and also the tibia adult is the elastically lowest strongest among of all with N (39.87107).

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