A BIOMECHANICAL STUDY ON THE SCALE OF THE TIBIA

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The purpose of this paper was to provide current biomechanical data on the tibia. X-ray pictures of the tibia were taken of 45 young boys, performing weight lifting and jumping. Some inactive subjects were also included. Measurements were taken to establish length, and thickness indexes Sporting background had no effect on the length or thickness index of the

$$\lambda = \frac{\mu\ell}{i} = \frac{\mu\ell}{\sqrt{\frac{J}{F}}}$$

tibia as measured by the Ohla formula.

KEY WORDS: tibia, scale of the length, thin and long pole

INTRODUCTION: The tibia plays a very important role in upholding the weight of the body. In addition, it is the bone injured most often in sport, therefore it is necessary to obtain current biomechanical information in this area. The findings from this study not only will benefit athletes in training and competition, but also will assist coaches, physiotherapists and professionals in the area of sports medicine.

METHODS: Data for the scale, length and thickness index of the tibia, came from x-rays of 45 young boys' (left and right tibias). The boys participated in jumping activities, in weight lifting or were inactive. The ohla formula and the parameter value that is quoted in this study was obtained from previous research related to the subject (Wang & Ye, 1981).
The length and thickness index related to tibia can be calculated by the following:
L is the length of the tibia, measured from the pictures of X-rays. μ is defined according to the supporting stand, , F and J are needed to calculate.
The determination of μ
The tibia is the primary bone of the shank. The calculating method of F.
According to the perspective of this article: The study of Geometry nature about human body's tibia, This article chooses 75% area value of the length of the bone. and J, So the area value of F can be calculated according to the circle area formula:

$$F = \pi(\beta - \gamma)^2$$

In this formula: β and γ are separately half of the diameter of diaphysis and the diameter of the narrow cavity of the tibia's relevant position.
The calculating method of J
This article regards 75 percent section of the length of the bone as the circle similarly, So the tiniest

$$J = \pi(D^4 - d^4)/64$$

moment of inertial.

In the formula, D is the diameter of diaphysis of tibia's relevant position d is the diameter of the narrow cavity.

The calculating method about the scope of application of Ohla formula.
Ohla formula is a formula which calculates the critical pressure of the pole ball It is the following form:

$$P = \frac{\pi^2 EJ}{\mu^2 \ell^2} \qquad \lambda_1 = \sqrt{\frac{\pi^2 E}{OP}}$$

in the formula P--The critical pressure, E--modulus of elasticity it is connected with the material quality of the pole, If we want to define the scope of application of ohla formula, It must be defined a limit value first. Suppose λ_1 stands for limit value, so in the formula, op is the proportion limit of the material, it is connected with the material quality. Only when $\lambda \geq \lambda_1$, the scale of the length and slender of the pole $\lambda \geq$ m limit value, ohla formula can be used, but the pole ball of $\lambda \geq \lambda_1$ is called a thin and long pole.

RESULTS: Table 1 provides data for the 3 groups.

Table 1 Each Subject's Tibia Table Concerned Index Value (The index chooses 75% the length of the bone,unit: mm)

	Common group		Weight-lift group		Jumping group	
number	The D of diaphysis	The D of the narrow cavity	The D of diaphysis	The D of the narrow cavity	The D of diaphysis	The Dof the narrow cavity
1	24.80	15.42	23.58	12.32	28.78	14.24
2	25.80	15.50	22.14	12.32	27.38	16.52
3	23.92	15.10	23.70	11.42	25.06	13.24
4	21.98	13.74	24.84	11.76	27.12	18.08
5	28.12	21.24	23.08	13.00	26.88	15.52
6	24.82	17.30	25.66	12.56	25.24	15.60
7	23.08	16.56	23.90	15.50	27.60	17.44
8	22.12	14.22	27.00	13.58	27.68	16.10
9	23.14	14.98	26.38	13.00	25.42	17.00
10	23.14	14.94	24.30	16.24	28.20	18.06
11	21.58	12.00	24.12	14.74	29.10	16.24
12	22.46	14.72	27.24	12.90	26.54	15.10
13	24.94	15.84	24.36	12.42	27.70	13.30
14	22.12	13.68	27.06	14.34	30.48	16.48
15	25.60	16.16	27.28	17.10	27.80	16.64

D, diameter.

Table 2 The Value of the Scale of the Length and Slender of Each Subject's Tibia

Number	The �value of common on group	The �value of weight lifting group	The�value of jumping group
1	51.5	54.7	46.8

2	48.9	58.4	49.6
3	54.3	54.2	57.8
4	56.5	53.4	52.8
5	40.4	47.8	45.9
6	50.8	48.1	51.2
7	47.6	55.4	50.3
8	54.2	53.7	53.7
9	47.9	41.9	54.9
10	52.0	46.7	52.0
11	56.7	53.2	49.2
12	53.1	48.4	51.4
13	50.1	46.1	46.6
14	53.5	46.5	50.0
15	53.9	45.8	51.9

The scope of application about ohla formula. According to the index value of table 1, the scale of the length and slender of each subject's tibia can be calculated, The results are in Table 2.

The average value of E(modulus elasticity)is 929.25kg/mm
According to this following equation

$$\lambda_1 = \sqrt{\frac{\pi^2 E}{\overline{OP}}}$$

Calculate:λ1=34
So to the bone material, so long as the scale of the length and slender λ34,the critical pressure can be calculated by ohla formula, and the bone, the scale of the length and slender λ34,is belong to a thin and long pole.
The result is compared with Table 2.We can see the scale of the length and slender of each tibia λ>34,so the tibia is belong to a thin and long pole.
The comparison of the average value of the scale of the length and slender of three groups tibias. Conducting the scale of the length and slender of three groups tibias variance analysis, the result is that there are no marked differences among them P>0.05,For details, see Table 3.

Table 3 The Variance Analysis Result of the Scale of the Length and Slender of Three Groups Tibias

Parameter	Common group		Weight lifting group		Jumping group		The F value of variance analysis	F0.05	P
	X	S	X	S	X	S			
The scale of the length and slender of the	51.4	4.0	50.3	4.5	50.9	3.1	0.2992	3.22	>0.05

DISCUSSION: According to the result obtained form this study, the tibia can be regarded as a thin and long pole ball, which may lose steady. Based on the knowledge of material mechanics, when a thin and long pole ball is subjected to pressure that is less certain extreme value, the pole ball can keep balance like the straight line shape, even it occurs winding and is out of shape by a ting cross range interference. But after removing the interference, it will still restore to the former state, but when the pressure reaches certain extreme value, straight line shape about the pole ball become unbalance, which affects a ting cross range and makes it winding and be out of shape. After removing, it will keep the curve shape balance and can not restore to the former state. We often observe slight 'O' shape legs in Wushu players and weight lifting players as well as other events players. This may be related to their tibia and thigh bone losing steady many times in their training. In other words, the leg's losing steady phenomenon may be one of the reasons that it causes acquired 'O' shape legs. Besides, When the pole ball loses steady, the structure of the pole may suffer destruction and break. This is one of the fracture reasons in sports.

In sports training, this situation that decides the load through experience, is more common. Based on the result of this study, Ohla formula can be used to calculate the critical pressure of the tibia, thus the trainers and players can control the training intensity according to the different situation in different period. So we not only arrange the training on the science and reliable base, but also prevent sports injury and avoid the deformity of the bone.

The mean values of the scale of the length and slender of tibia are smaller sports groups rather than those values in common group. There are no marked differences among three groups, It shows that the scale of the length and slender is a steady parameter of human body's tibia, Being engaged in sports or not, their tibias are belong to thin and long poles, losing steady is possible. For example, we can see the leg bone deformity—'O; shape leg in all kinds of players, we can also see in those who aren't engaged in sports, so we not only pay attention to prevent that when the bone suffers strong shock, the strength is not enough, and causes it injure, but also prevent that those are not because of the strength ,yet losing steady of tibia causes to be out of shape and injury.

This article calculates relating data about 45 boys' tibia and statistics handle. The results showed that: The scale of the length and slender of young boy's tibia is:

Common group: λ=51.4$\pm$ 4.0

Weight lifting group: λ=50,3$\pm$ 4.5

Jumping group: λ=50.9$\pm$3.1

2.Human body's tibia is belong to thin and long pole ball, It is possible to lose steady. The O type leg appearance of some players and heavy physical laborers and some sports injury about the bone, these may be connected with the losing steady of the tibia.

Being engaged in special sports or not, there are no marked differences between their scale of the length and slender of the tibias, It shows that the scale of the length and slender is a steady mechanics parameter of human body's tibia.

REFERENCES:

Wang, Y., & Ye, J. (1981). A study of winding intensity of human body's tibia. *A Collection of the Thesis of the First National Biology Mechanics Discussion Meeting,* Volume A.

Shen, J., & Cheng, X, (1981). A study of the Geometry nature of human body's tibia, A *collection of the thesis of the first National biology mechanics discussion meeting* Volume A.

Liu, H.W. (1981). *Material Mechanics.* Beijing, China: People's Education Publishing House.

Ma, Y. et al. (1979), *Material Mechanics.* Beijing, China: People's Education Publishing House.

China Medical University (1978). *Human Body's Dissect Anatomy*. China: People's Health Publishing House.