MORPHOMETRIC STUDY OF THE PROXIMAL EXTREMITY OF THE TIBIA

COSMIN IOAN MOHOR[1]

[1]"Lucian Blaga" University of Sibiu

Keywords: *tibia, proximal extremity, tibial plateau*

Abstract: *The proximal extremity of the tibia can boost the development of genu valgum, more frequently in females. These changes can lead to the occurrence of arthrosis modifications of the knee joints. Early diagnosis and prophylaxis of the mechanical ethiology of such modifications involving the knee can result in a significant decrease of patients' chance of developing gonarthrosis. The current study aims at identifying the modifications of the proximal extremity of the tibia that actively favour the development of genu varum.*

Cuvinte cheie: *tibia, extremitate proximală, platou tibial*

Rezumat: *Extremitatea proximală a tibiei favorizează apariţia unui genu valgum, mai frecvent în cazul sexului feminin. Aceste schimbări conduc la apariţia modificărilor de artroză la nivelul articulaţiilor genunchiului. O diagnosticare precoce şi profilaxie asupra etiologiei de ordin mecanic a modificărilor de la nivelul articulaţiei genunchiului vor avea ca rezultat o scădere a incidenţei apariţiei gonartrozei, în special la sexul feminin. Studiul de faţă îşi propune să afle modificările extremităţii proximale a tibiei care favorizează apariţia unui genu varum.*

INTRODUCTION

The tibia is a long bone located on the internal side of the lower leg. It is composed of two extremities. The proximal extremity participates in the formation of the knee. It is large, transversally elongated and features two condyles – lateral and medial. They each feature an articular surface, which is lightly excavated. Between these surface, one can notice a bony prominence – the intercondilary prominence – which divides the articular surface in two intercondylar areas – anterior and posterior.

On the front facet of the proximal extremity of the tibia lies the tibial tuberosity – the place where the patellar tendon is inserted. The tibial tuberosity is found at around 4-5 cm under the peak of the patella.(5)

Dai Sun Kwak published a study in Science Direct in which he evaluates the degree of asymmetry of the resected proximal tibial surface, also measuring the medial anteroposterior (MAP) and lateral anteroposterior (LAP) lengths of the respective condyles and calculating the difference between them. There has been found that the medial tibial plateau is larger than the lateral tibial plateau, anteroposteriorly by an average of 3.9 ± 2.9 mm in males and 3.7 ± 2.7 mm in females.(11)

There are theoretical and methodological morphometric approaches in evolutionary anthropology and paleoanthropology reviewed in different studies, showing which are the contemporary possibilities of sophisticated biometrical and biostatistical methods and the role of the morphometric approach. A new approach, experimental morphometrics, is presented, reflecting recent trends in evolutionary morphology as well as sophisticated biostatistical methods. The approach emphasizes the complex inter-related approach to the data processing and a double nature of morphometric data, i.e. biological and biostatistical one. The practical use of experimental morphometry is given for the two examples of analyses of the evolution of the hominoid and hominid femur and tibia. The hypothesis of a two stage restructuring of morphology of the hominid femur and tibia is supported by experimental results. Two different steps during this restructuring could be recognized: 1) Structural remodelling typical for the origin of hominids and australopithecine evolution and 2) proportional remodelling of lower limb long bones which is connected with the Australopithecus/Homo transition (i.e. mainly Homo habilis stage). The results confirm the increasing trend of bipedal adaptations on the early hominid lower limb skeleton. Analysis of microevolutionary trends on the Homo sapiens femur and tibia indicates at least three different morphological patterns, Paleolithic, Neolithic and Recent, with numerous specific features in morphology and proportions. Neanderthal morphology is much derived. Upper Palaeolithic/Mesolithic/Neolithic transition has a key character for the understanding of post-Palaeolithic morphology. A very high sexual dimorphism of the femur and tibia has been demonstrated for Upper Palaeolithic and Neolithic populations.(12)

The most common reason for disorders of the knee joint is cartilage wear (arthrosis), mainly caused by a misalignment of the leg axes (in-knee or out-knee). In addition, gonarthrosis also occurs as the consequence of injuries, rheumatic and metabolic disorders as well as deformities.

The loss of cartilage results in increasing stiffening and deformation of the joint. Bony spurs (osteophytes) form, which sometimes can be palpated from the outside. At the same time, pains occurs, first associated with initial movement after periods of inactivity and with stress, later also at night and at rest, resulting in an increasing limitation of the walking range and ultimately in a reduction in quality of life. The arthrosis can be shown in the normal X-ray image; the narrowing of the joint cavity between the femur and the tibia can be seen as an indirect indication of the loss of cartilage.(13)

[1]Corresponding author: Cosmin Mohor, Str. Lucian Blaga, Nr. 2, Sibiu, România, E-mail: cimohor@yahoo.com, Tel: +40740 763100
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A recent report found that the alignment of a knee replacement implant is critical to the longevity of the implant. When your surgeon implants a knee replacement, specific bone cuts are made to shape the joint for the implant. Depending on how those cuts are made will determine the alignment of the implanted prosthesis.(14)

PURPOSE

The purpose of the study is to highlight the way in which modifications related to the knee occur in human individuals, modifications that may favour gonarthrosis.

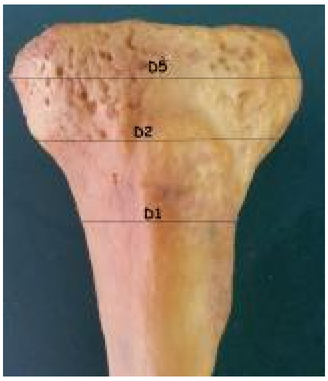
METHODS

For this particular study, I have considered 200 X-ray examinations of the knee, in women, in front-rear incidence, and 20 didactic-purposed tibial plateaus, specially prepared in the human anatomy and embryology laboratory.

There were calculated, for each case, the following morphometric parameters (figures no. 1, 2):
D1 - The diameter corresponding to the horizontal plain tangent to the inferior extremity of the tibial tuberosity;
D2 - The diameter corresponding to the horizontal plain tangent to the superior extremity of the tibial tuberosity;
D3 – The internal diagonal of the tibial plateau;
D4 – The external diagonal of the tibial plateau;
D5 - The horizontal diagonal corresponding to the tibial plateau;
D6 – The height of the internal tibial condyle;
D7 – The height of the external tibial condyle;

Figure no. 1. Presentation of the morphometric parameters of the tibial plateau

Figure no. 2. Presentation of the morphometric parameters of the tibial plateau



Furthermore, I have also considered the side of the limb (L-left, R-right) in six different age categories: adults between 21 - 30 years old, 31 - 40 years old, 41 - 50 years old, 51 - 60 years old, 61 - 70 years old, 71 - 80 years old.

Focusing on the patients in the age category between 21 - 30 years old, 17 in total, I have graphically displayed the measurements in figure no. 3. I can notice a conformation of the proximal epiphysis of the tibia that is characteristic to a valgum deviation of the knee. This deviation is knowingly considered physiological, being caused by pressure mechanical forces acting on the tibial plateau - the internal tibial condyle is actually supporting 60% of the body weight.

In figure no. 4, I highlighted the values taken from patients aged between 31 - 40 years old. The subjects belonging to this age group have been noticed to know a conformation of the proximal tibial epiphysis in concordance to a valgum deviation of the knee, but also tending to self-repositioning on a normal axis. Out of these, 4 cases feature a conformation that is favouring a valgum deviation of the knee, while the deviation of three of the four is actually significant.

Figure no. 3. Measurements made in female patients aged 21-30 years old

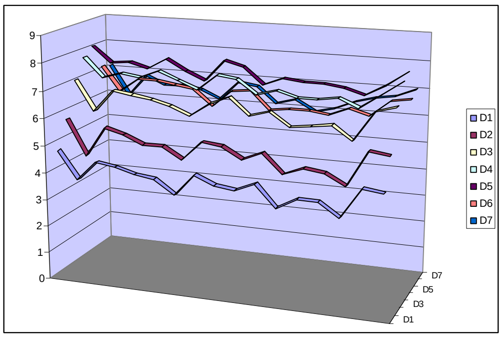
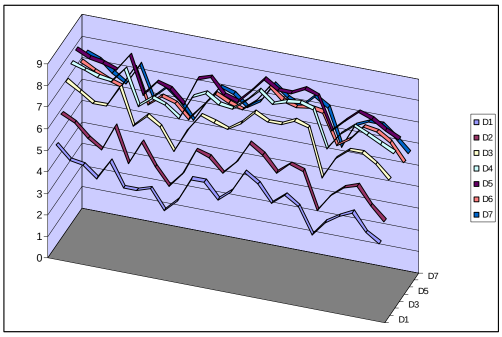


Figure no. 4. Measurements made in female patients aged 31-40 years old



In the case of the subjects aged between 41 – 50 years old, the dimensions of the tibial condyles are roughly equal, with no significant difference between them.

For the ones aged between 51 – 60 years old, I also noticed a conformation of the proximal epiphysis of the tibia that is characteristic to a physiological valgus of the knee.

Considering the age group of 61 - 70 years old, the conformation of the proximal epiphysis of the tibia is characteristic to a physiologic valgus. Out of these, 6 cases are featuring significant dimensional differences between the tibial condyles.

The last category of age, between 71 - 80 years old, the tibial condyles feature roughly equal dimensions. Seven cases belonging to this category still boast a difference that may produce axial damage to the knee.

RESULTS AND DISCUSSIONS

Out of the group between 21 - 30 years old, 10% showed a conformation of the proximal tibial extremity that may lead to genu varum.

Related to the 31 - 40 year-old patients, around 16% feature proximal tibial extremity conformation in favour of developing genu varum.

Approximately 36% of the subjects aged between 41 and 50 years old come with proximal tibial extremity conformations favouring the development of genu varum.

For those belonging to the category of age between 51 - 60 years old, roughly 32% show a structural conformation of the proximal extremity of the tibia that may lead to the development of genu varum.

In the case of the 61 - 70 and 71 - 80 age groups, 36% of them have been found with proximal tibial extremity conformations favouring genu varum.

CONCLUSIONS

1. The conformation of the proximal extremity of the tibia, due to the modifications that occur during life, tends to favour the development of genu varum.
2. The data found in common literature, referring to male subjects, compared to female subjects, display a tendency for the development of axial changes in the knee, specific to gonarthrosis, two times lower.
3. As human subjects advance in terms of age, the percent of women risking development of genu varum grows proportionally to the age.
4. Extensive knowledge of the morphological variations of the tibial plateau can lead us to better preventing and preparing the possible surgical interventions on the knee.

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