

Clinical Importance of Proximal Tibia in Total Knee Arthroplasty

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Abstract – The tibia is a thick and strong bone located medial to the leg. It is the longest bone in the body after the os femoris, supporting the body weight and transferring this weight to the talus via the ankle joint via the os femoris. It has two ends and a body. It articulates with the femur, fibula and talus. Total knee arthroplasty is used as an important treatment option in cases where conservative treatment options are not effective or in advanced degenerative disorders. The need for total knee arthroplasty surgery is increasing with advancing age. The general aim of total knee arthroplasty is to correct deformities, restore the function of the knee joint and relieve long-term pain. Thus, it helps both psychological and physical recovery by improving the patient's quality of life. Success of surgical intervention depends on the surgeon's experience and knowledge of the anatomy of the proximal tibia. Appropriate tibial implants will ensure the longevity of the knee prosthesis and rapid movement of the patient. Anthropometric data must be accurate and reliable in order to use the implant in a healthy way for many years. Differences between age, gender and race are clinically important in determining the dimensions of inserted prosthetic components. Defining the morphologic and morphometric properties of the proximal tibia will be useful in improving prosthesis fit, manufacturing and application. Morphometric studies on the proximal tibia in the Turkish population are scarce and these studies will significantly contribute to the design of the tibial component of the total knee prosthesis.

Keywords – Anatomy; Proximal Tibia; Total Knee Arthroplasty; Morphometry; Orthopedics

I. INTRODUCTION

Total knee arthroplasty (TKA) is used as an important treatment option in cases where conservative treatment options are not effective or in advanced degenerative disorders. Success of surgical intervention depends on the surgeon's experience and knowledge of the anatomy of the proximal tibia. An ideal prosthesis should allow near-normal range of motion of the knee, should not alter joint kinematics and should maintain anatomical integrity. In addition to providing knee kinematics, joint stability is essential for normal joint function. Age, gender and racial differences are important in determining the size of the inserted prosthetic components. We believe that defining the morphologic and morphometric properties of the proximal tibia will contribute to the development of prosthetic fit, production and application areas.

II. ANATOMY OF THE PROXIMAL TIBIA

The tibia, located in the medial part of the leg, is a thick and strong bone. It is the longest bone in the body after the os femoris and supports the body weight and transfers this weight to the talus via the os femoris via the ankle joint. It has two ends and a body. It articulates with the femur, fibula and talus [1], [2]. The homolog of this bone in the upper extremity is the radius bone [3].

The medial condyle and lateral condyle are wider at the proximal end and articulate with the femur [4]. These condyles are enlarged to accommodate the corresponding condyles of the femur [5]. The medial condyle is larger than the lateral condyle with an oval articular surface and a longer anteroposterior axis. The central part of the articular surface is concave and in direct contact with the medial condyle (femoralis). The peripheral part is flat and articulates with the condyle of the femur through the medial meniscus. The upper articular surface of the lateral condyle is rounded and like the medial condyle, only the central part is in direct contact with the lateral condyle (femoralis) [3]. The articular faces located on the condyles and articulating with the femoral condyles are called superior articular facet [1]. On the posterior outer side, the fibular articular facet is located in an oblique plane and articulates with the caput fibula. Between the lateral and medial articular faces, there is a height in the middle. This is called the intercondylar eminence. The medial and lateral

parts of this elevation partially rise and form the medial intercondylare tubercle and lateral intercondylare tubercle [2].

The tibial tuberosity is a perforated triangular area on the anterior surface of the proximal end of the tibia. Patellar ligament attaches to this area [1]. This structure forms the anterior edge of the area intercondylaris and continues inferiorly with the anterior margin of the tibia. It is divided into two sections, the upper smooth and the lower rough, and the epiphyseal line passes between these two sections [3].

III. TOTAL KNEE ARTHROPLASTY AND ITS CLINICAL IMPORTANCE

Total knee arthroplasty (TKA) is a common surgical treatment to reduce pain, restore mobility and improve quality of life [6], [7], [8]. The need for total knee arthroplasty surgery is increasing with advancing age. The general aim of TKA is to correct deformities, restore the function of the knee joint and relieve long-term pain. Thus, it helps both psychological and physical recovery by improving the patient's quality of life [9], [10].

Proximal tibial morphometry is important for surgeons to perform successful total knee arthroplasty. A better understanding of the proximal tibial anatomy is essential to design appropriate tibial implants [11], [12], [13], [14]. In order to use the implant in a healthy way for many years, anthropometric data must be accurate and reliable [15], [16], [17].

Appropriate sizing of the tibial component in TKA is important to maximize load transmission proximal to the tibia. If the tibial component of TKA is small, loosening of the prosthesis may occur in the early period due to insufficient support of the tibia. A small tibial component carries a greater risk for unicondylar knee arthroplasty (UKA). If the implant used is larger than necessary, the protruding part may cause irritation of the soft tissues and cause pain in the patient [18]. The geometric structure of the medial and lateral condyle surface of the tibia directly affects the biomechanism of the tibiofemoral joint. In rotational movements of the knee, the position of the center of gravity changes abruptly and this causes strain on the knee ligaments, especially the anterior cruciate ligament [19].

Proper prosthesis design is very important to maintain function and motion of the knee after surgery [20]. Appropriate tibial implants will ensure longevity of the knee prosthesis and rapid movement of the patient [21]. Incompatible tibial implant leads to increased wear instability, misalignment and separation of prostheses in the long term [15], [22]. In arthroplasty, patient-specific prosthetic implants may eliminate implant incompatibility in the near future [14].

A characteristic feature of the proximal tibia is that it has a posterior slope. This slope, protects the stability of the knee joint by creating an anterior resistance during weight transfer. A particularly severe medial posterior slope allows the tibia to be subjected to less resistance than the femur during movement of the knee joint. However, this creates a risk of increased injury to the knee ligaments, especially the anterior cruciate ligament [23].

In the literature, there are studies proposing gender-specific implants [24]. Many studies have shown that current implant sizes do not adequately match the morphometric diversity of different populations [12], [21], [25], [26], [27], [28]. Anthropometric studies of the tibia have reported that tibial implants for total knee arthroplasty are not fully suitable due to racial differences [25], [29], [30], [31].

There are studies reporting that the knee morphometry of the Asian population is smaller in size than the knee morphometry of the western population [21], [25], and there are also researchers who found no difference between European and African population parameters [32]. Artificial knee joint prosthesis systems commonly used in China are designed according to the anatomical characteristics of European and American populations. When these joint replacement systems designed for Western patients are used in Asian patients, prosthesis incompatibility often occurs due to ethnic differences [30], [31]. Some studies have found that the Chinese population has lower and flatter anterior condyles and wider posterior condyles than westerners [30], [33].

Aktemir Aktaş et al. [14] used 57 dry bone tibiae in a study evaluating the morphometry of the proximal tibia. The anteroposterior and mediolateral dimensions of the tibial condyles, the width of the tibial plateau, the anteroposterior and mediolateral

dimensions of the intercondylar area, the length of the tibia and the morphometric measurements of the Gerdy tubercle were measured with digital calipers. In his study, he emphasized that the production of prostheses to be used for arthroplasty specifically for the patient will reduce the incompatibility in prosthesis applications. Bilkay et al. [18] measured the anteroposterior and mediolateral dimensions of the tibial condyles, the transverse lengths between the outer edges of the medial and lateral condyles, and the inclinations of the medial and lateral condyles of the tibia towards the posterior in the transverse plane with Image J program. It was observed that the proximal tibia characteristics of the Turkish population were generally different from those of the Chinese and Caucasians.

IV. CONCLUSION

The morphometric values of the proximal tibia are important for prostheses to be used in surgical interventions such as total knee arthroplasty. It is clinically important to determine the morphometric properties of the proximal tibia and to make comparisons between age, gender and races. We think that prostheses should be designed specifically for individuals and races. Morphometric studies on the proximal tibia in the Turkish population are scarce and these studies will significantly contribute to the design of the tibial component of the total knee prosthesis.

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