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Tibia Valga Morphology in Osteoarthritic Knees: Importance of Preoperative Full Limb Radiographs in Total Knee Arthroplasty

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ABSTRACT

Osteoarthritis of the knee is associated with deformities of the lower limb. Tibia valga is a contributing factor to lower limb alignment in valgus knees. We evaluated 97 valgus knees and 100 varus knees. Long-leg films were taken in weight bearing with both knees in full extension. For valgus knees, 52 knees (53%) had a tibia valga deformity. Average tibia valgus deformation was 5.0°. For varus knees, there was only 1 case of tibia valga (1%), with a deformation of 2.5°. The aim of this study was to assess the prevalence of primary tibia valga in valgus and varus knees and understand how it affects our approach to total knee arthroplasty (TKA). We recommend having full-leg length films when planning for TKA in valgus knees.

Multiple risk factors have been linked to osteoarthritis (OA) in epidemiological studies [1–3]. Mechanical, biological, traumatic or a combination of these factors can lead to degenerative changes resulting in functional deterioration of the knee [2,3]. The degree of lower limb malalignment influences the rate of structural progression of degenerative changes in the arthritic knee [4,5]. One important measure of limb alignment is the hip–knee–ankle angle (HKA) [6–8]. The HKA defines the dynamic load distribution across the medial and lateral knee articular surfaces. In neutrally aligned limbs, the medial compartment bears 60% to 70% of the force across the knee during weight bearing [9,10]. The wide variation in lower limb alignments among normal individuals makes it difficult to define the normal spectrum [11]. The deviation from the neutral mechanical axis can arise from intra-articular or extra-articular deformities (the femur, the tibia or both) [12]. Historically, valgus knees have frequently been associated with distal metaphyso-epiphyseal femoral deformities (lateral condyle hypoplasia). In a study aiming to evaluate femoral hypoplasia as a cause of valgus knee, the average difference between medial and lateral condyles radii was 0.2 mm, with larger lateral than medial femoral condyle ($P < 0.006$) [13]. A valgus deformity of the tibial diaphysis was reported in one patient to be a contributing factor to the deviation of lower limb axis in a knee with valgus angulation [14]. In our practice we observed that such primary valgus deviation of the tibial diaphysis (not associated with any pathological cause or surgery) was present in many TKA cases performed for degenerative valgus knees. Therefore, we attempted to quantify the tibia valga prevalence and its contribution to overall lower alignment in valgus and varus arthritic knees and to evaluate its potential impacts on TKA procedure.

Materials and Methods

We retrieved from our database the patients operated for a TKA between 1994 and 2011. The operating surgeons classified the pre-surgery lower limb alignment as valgus or varus. Various methods have been utilized by each surgeon to classify the preoperative arthritic knee in our database based on overall alignment; those methods include combination of the physical examination [15] and the measurement of either/or both anatomic axis (6.85° ± 1.4°) [12,16] and mechanical axis using HKA [7]. In the neutrally aligned limb, the HKA angle approaches 180° (Varus deviations are negative HKA angle and valgus deviations are positive HKA angle) [17]. Inclusion criteria to the study group consisted of all patients of any age or gender with a full-leg hip to ankle preoperative radiographs in valgus mechanical axis alignment (Valgus alignment: knee center is medial to the line connecting the hip center to the centre of the talus (HKA is positive)) [17].

The inclusion and exclusion criteria were set so only idiopathic knee arthritis will be evaluated. Exclusion criteria included arthritic knees of traumatic or congenital cause, previous femoral or tibial osteotomy, previous fracture of the lower limb with or without internal fixation, and previous partial arthroplasty of the knee or total ankle arthroplasty. One hundred and thirty TKAs were preoperatively

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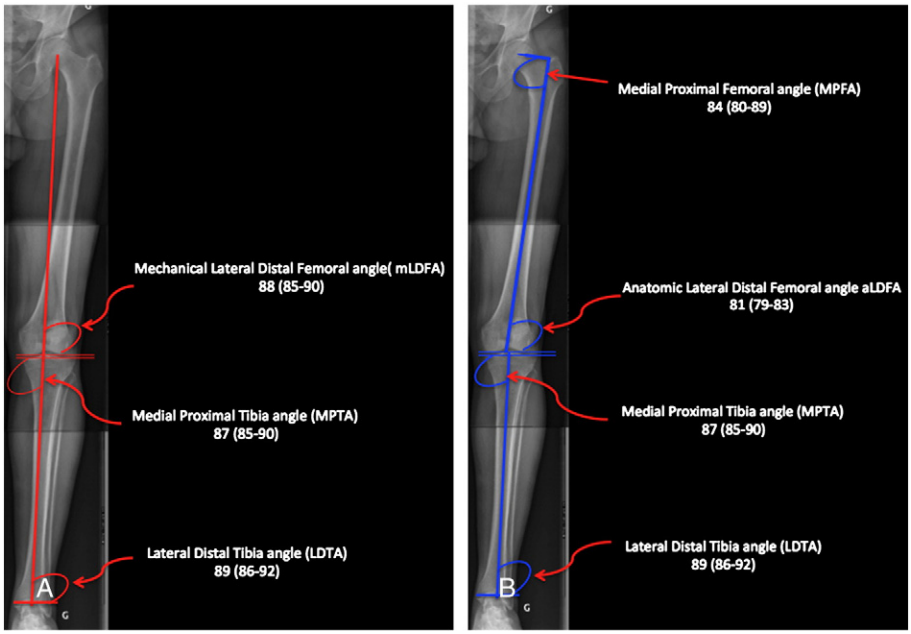

Fig. 1. (A) Normal mechanical alignment. (B) Normal anatomic alignment.

classified as valgus aligned in our database, only ninety-seven knees in 62 patients have long-leg films with arthritic knee of non-traumatic and non-congenital cause, furthermore, valgus arthritic knee with previous osteotomy around the knee or arthroplasty was excluded. There were 56 female and 6 male patients. We also reviewed the first 100 patients with preoperative arthritic varus knee alignment that underwent TKA in 2012. The same exclusion criteria were applied and this group was utilized as comparative group. There were 77 females and 23 male patients in the varus alignment group.

Long-leg films were taken with both knees in extension under total weight bearing. The knees were positioned so both knee caps were facing forward. This standard position ensured that the tibias were vertical and facing forward with minimal rotation.

Two trained orthopaedic surgery fellows (AA and MR) did all the radiographic measurements. We used a handheld goniometer for all hard-copy long-leg films (28 valgus cases). The remaining cases were digital films (69 valgus cases, 100 varus cases) and it was measured using Inteleviewer (Intelerad Medical Systems Incorporated, Montreal, QC Canada) [18]. These systems use a software with the digital equivalent of a ruler, circle, and goniometer tools to define bony landmarks and make measurements. In general, good agreement was found between digital systems results and those of manual methods [19,20]. The key anatomic landmarks were identified (Fig. 1A & B).

Both the tibia and the femur have mechanical and anatomic axes. Longitudinal shapes of the tibia and femur are variable [21,22]. The knee has various center points identified in the literature, around which mechanical axis is measured [7,23]. We used separate center points for both femoral and tibial side instead of single knee center, this choice was based on anatomic studies [24], and the belief that such an analysis would determine the contribution of both tibial and femoral morphology to the overall alignment (a feature less available when using a single knee center-point). The center of the femoral head was defined using the Mose template in plane films [25]. In digitised films, we used a draw toolbar to sketch the hip centre using the femoral head centre. The centers of the femoral intercondylar notch and center of the tibial spines, respectively, denote the locations of the femoral axis distally and the tibial axis proximally [17]. Because of the distorted anatomy of the arthritic knee joint, the tibia spine might not be clearly evident on plane radiograph; the mid-point of the tibia plateau is used in this case instead of the center of tibial spines. The center of the talus was used as a mark for the tibial axis distally [12]. The line connects the center of the femoral head and the center of the femoral intercondylar notch defines the mechanical axis of the femur [17]. For the anatomic axis of the femur, a line connecting multiple bicortical centers (2–3 points) of the proximal and distal 10 cm of the femoral shaft was used to define the anatomic axis [22,26]. When this line is not passing central through the femoral

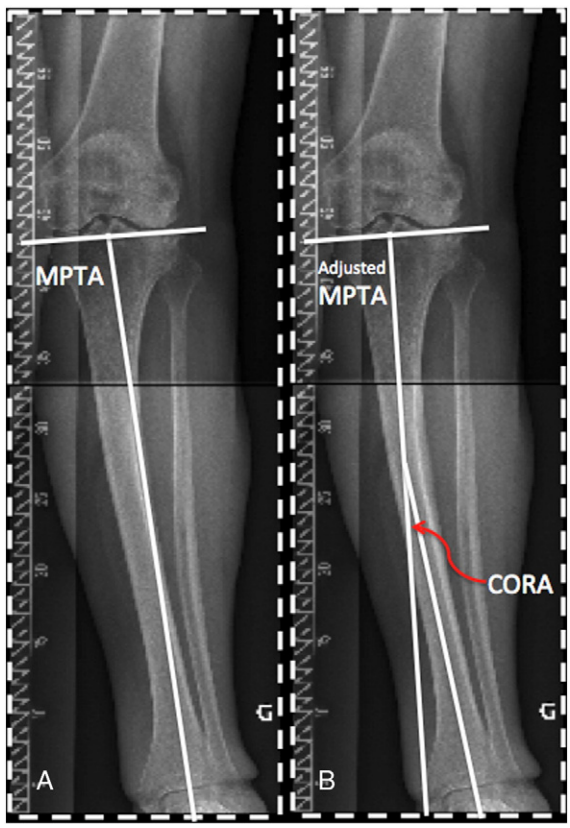

Fig. 2. (A) Medial proximal tibia angle (MPTA). (B) Adjusted-MPTA in tibia valga.