Knee Alignment and Its Significance: Is It Really Different in Various Population Groups?

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KEY WORDS: genu varum, genus valgum, knee alignment, adolescence, osteoarthritis

IMAJ 2018; 20: 109–110

Knee alignment is a well-known physiological process in infancy through adolescence as the knee position changes with age. The maximum varus angle (genu varum, also called bow-legs) peaks at 6–12 months of age. By the 24th month of age, the knee gradually straightens and continues to shift to the valgus position (genu valgum, commonly called knock-knee), which culminates around 3 to 4 years of age [1]. Until the age of 7, the valgus knee corrects itself to the adult alignment of around 7 to 8 degrees. Women have a higher valgus position, which is attributed to their pelvic structure.

Any knee alignment disorder, such as genu varum or genu valgum, during adolescence can cause a variety of problems in adulthood, particularly osteoarthritis. In the genu valgum position, the weight-bearing line will pass from the midway and distribute to the lateral compartment of the knee, while in the genu varum position, it will distribute to the medial one. These misalignments can progressively lead to osteoarthritis and pain [2,3]. Other problems include lack of stability, patellar maltracking and instability, overload on the collateral ligaments, and meniscal tears [4].

To understand knee alignment, we need to consider both the roentgen and the physical examination.

Roentgen: the mechanical axis angle of the lower limb containing the knee joint can be precisely measured through two lines. The first line is from the center of the femoral head to the center of the tibial spines. The second line is from the center of the talus to the center of the tibial spines. This two-line intersection computes the mechanical axis angle [3]

Physical examination: the clinical method to determine knee alignment is based on the standing position of the patient. The hips and knees are in full extension and the position of the lower body is in neutral rotation. In this position one can see whether the knees are touching each other. The clinician can also calculate the distance between the medial femoral condyles (intercondylar distance [ICD]) or the distance between the medial malleoli (intermalleolar distance [IMD]). These distances can be measured using a measuring tape and can determine genu varum or genu valgum.

KNEE ALIGNMENT

The question arises whether knee alignment is affected by factors such as socio-demographic factors, physical status, and sports activity. Many researchers have tried to find the connection between those factors and knee alignment.

KNEE ALIGNMENT AND SOCIO-DEMOGRAPHIC DIVERSITY

From the socio-demographic point of view, one can compare different populations. Kumar et al. [5] conducted a study of knee angles of Indian children from the Andhra Pradesh state, India. The added value of studying children from this geographic area is that many of the people living in this area are still isolated from those from other regions. In this way researchers can study the effects of the physical development in the population.

Kumar and colleagues used a goniometer on 360 normal Indian children from 2 to 14 years of age. They found that the physiological varus rarely persisted after 2 years of age, and later increased to the valgus position to a maximum of 8° in girls and 6° in boys. By the age of 10, the valgus decreased to 6–7° for both boys and girls [5].

Another study by Omololu and colleagues [6] on the Nigerian population from West Africa studied the normal angles through the ICD and IMD distance of 2166 Nigerian children between 1 and 10 years of age. Each age group was comprised of at least 100 children. They found that the maximal varus knee occurred at 1–3 years of age, followed by a neutral angle at 5 years of age in girls and 7 years in boys, ending in valgus angle of about 11° in both genders.

Concerning the American population, Engel and Staheli [7] studied 160 children from 1 day old to 14 years of age. They found that all of the children younger than 1 year of age had varus of 5° and as they got older and entered adolescence, the valgus was 4.5°.

Sellanius and Vankka [8] described a larger study on European children from Finland. The study included 1480 children from birth to age 16 years. Each group contained an average of 40 children with intervals of 6 months in each age group. The children were examined, and the tibiofemoral angle (the angle formed between femur axis and tibia axis) was determined. The authors found that the mean varus angulation was 16.5° at birth and continued to neutralize by about 1.5 years of age. The valgus position was corrected sponta-

neously from a maximum 12° at 3 years of age to 6° at about 7 years of age, both in girls and boys.

KNEE ALIGNMENT AND BODY WEIGHT

Another factor that can affect the final knee alignment is the physical status of the child, especially those with a high body mass index (BMI). An increased BMI has a direct influence on knee alignment, namely genu valgum. de Sá Pinto and colleagues [9] found a higher prevalence of genu valgum in 49 obese children. Taylor et al. [10] conducted a comparative study on 91 non-overweight and 159 overweight children and found more valgus deformity in the overweight children.

Recently, another large study on 47,588 Israeli adolescents, which is reported in this issue of *IMAJ*, was conducted by Shohat and co-authors [11]. This study also supported these findings, showing a direct relation between the increase in BMI and the valgus deformity in adolescents, with a higher prevalence shown mainly in girls.

Nutrition is also thought to impact the physical status in children, and consequently knee alignment. Volac et al. [12] studied European children during the winter-spring time, a period with a diet low in calcium and milk intake. The study comprised 226 children between 7 and 16 years of age. The prevalence of genu valgum was 15% in those children with low vitamin D levels. Children with levels below 30 nmol/L showed the highest prevalence (36%) of lower limb deformities.

KNEE ALIGNMENT AND SPORTS ACTIVITIES

Sports activities and the relation to knee alignment deformity is well-known. Genu varum or valgum is a predisposing factor to sports injuries caused by overuse [13], but little is known about general sports activities and their effects on the knee alignment. It is hypothesized that during prolonged sports activity, high load and stress levels are applied to the knee joint, which eventually can affect the growth plate and consequently cause growth deformity [14].

Witvrouw and colleagues [15] compared 366 soccer players to 458 non-soccer players between 8 and 18 years of age and found that soccer players more frequently developed genu varum.

CONCLUSIONS

In conclusion, many factors contribute to the final knee alignment in adulthood. Socio-demographic factors, physical stature, and sports activities should be considered as influencing and impacting knee alignment.

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Capsule

Elucidating a bacterial sense of touch

Bacteria can adhere to surfaces within the host. This leads to tissue colonization, induction of virulence, and eventually the formation of biofilms, which are multicellular bacterial communities that resist antibiotics and clearance by the immune system. **Hug** and co-authors showed that bacteria have a sense of touch that allows them to change their behavior rapidly when encountering surfaces. This tactile sensing makes use of the inner components of the flagellum, a rotary motor powered by proton motif force that facilitates swimming toward surfaces. Thus, the multifunctional flagellar motor is a mechanosensitive device that promotes surface adaptation. In complementary work, Ellison and co-authors elucidated to the role of bacterial pili in a similar surface-sensing role.

Science 2017; 358: 531, 535

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