Loading conditions of the knee: what does it mean?

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Bracing, for unloading the knee on healthy subjects, was studied in the leading article of the current issue by Orishimo et al. [12]. Loading or unloading the knee is a very interesting and important aspect when postsurgical treatment of cartilage or meniscal lesions is discussed.

Research about knee loading has been of interest for more than 30 years using finite element models [2], force plates [5] and in vivo technology [15]. Some very interesting in vivo data have shown that walking causes femorotibial peak forces of 261 % body weight and descending stairs up to 346 % of body weight [7]. Knee loading can increase up to 550 % body weight during sudden balance loss, showing the importance of the interaction of the muscles. It is well known that the medial compartment takes significantly more load than the lateral one, which is on average 60–70 % of the load during level walking. Loading can rise significantly in osteoarthritic knees [6, 8].

A minor change in leg alignment shifts the load to the medial or lateral compartment. This has been known for many years and has been the basis for internal or external correction of the leg alignment [1, 13].

Gait analyses have shown that the adduction moment depends more on leg alignment rather than the degree of OA [4]. The adduction moment serves as the surrogate for medial compartment load.

Despite the strong correlation between the mechanical axis and the adduction moment, other factors such as increased rearfoot eversion, rearfoot internal rotation and forefoot inversion cause reduction in loading of the medial compartment [9]. Thus, it seems to make sense to perform a “brace-test”, for instance, before high tibial osteotomy is considered in osteoarthritic knees. By using a brace in 4° and 8° valgus in osteoarthritic knees, the reduction in medial tibial loading was 24 and 30 %, respectively [8]. However, this data seem to depend on the type of brace.

As previously mentioned, Orishimo et al. [12] performed their study on healthy subjects and not on patients suffering from osteoarthritis. Increased valgus stress decreased the adduction moment by 32 %. These data are comparable to findings in osteoarthritic patients. However, what would the clinical relevance be of lowering the adduction moment by 20 or 30 %? How much unloading of a compartment would be required to improve clinical symptoms, allow cartilage regeneration and or meniscus healing?

The current guidelines of postsurgical knee loading after cartilage repair, meniscus surgery or osteotomy are mainly based on clinical experience. However, there is published data which, for example show that by decreasing the adduction to <2.5 % body weight × height in patients after high tibial osteotomy showed better clinical outcome compared to patients without bracing [14].

How much correction do we need in order to not only relieve pain but also prevent progression of femorotibial OA? Many authors refer in clinical and basic science studies to the Fujisawa-point, a point where the mechanical

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axis crosses the tibial plateau [3]. This point is between 60 and 70 % considering the lateral border of the plateau is 0 % and the medial one 100 %. In this study, patients presented with the best clinical outcome when corrected into this range. A recent study by Lind et al. showed that a correction of the mechanical axis of the leg to 62.5 % of the width of the tibia plateau lead to a decreased adduction moment of 2.8 % body weight $\times$ height [10]. Though, a correction between 60 and 70 % seems to make sense taking the clinical and biomechanical data into consideration.

However, we do not know exactly how much overloading of the contralateral, non-affected compartment will accelerate the degeneration. Also, we do not know exactly how much unloading might prevent or delay further degeneration or even how much loading or unloading cartilage can tolerate or require?

Unloading of the knee for 2 months using two mono-tube external distractors showed clinical improvement and cartilage regeneration in young patients suffering from osteoarthritis [16]. The minimal joint space width increased significantly from 1.1 to 1.7 mm and remained at that level for up to 2 years.

By contrast, in vitro studies have shown that biological and biomechanical properties of human chondrocytes seeded in collagen type I hydrogel were significantly increased when cyclic compressive loading was applied [11]. This shows that cartilage requires loading in order to maintain its intrinsic capability to sustain load.

On the one hand, we need knee loading in order to have durable cartilage, but on the other hand, we need some kind of unloading in order to allow healing and repair of tissue.

Better understanding of knee loading may help us to find more biological ways to treat these kinds of knee pathologies.

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