

Advantages and Disadvantages of Neutral Alignment

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1. Primary concept

Proper coronal alignment is very important for implant longevity as well as knee function after total knee arthroplasty. Classically, within 3 degrees from neutral alignment has been recommended.

2. Advantages of neutral alignment

a) Less stress on the bone and implant

FEA model showed neutral alignment significantly decreases stress at the bone, compared with varus alignment (*Wang J et al, J Orthop Res, 2011*). High stress at the tibial bone would be a risk for tibial collapse. Varus alignment also increases contact stresses on the polyethylene, increasing wear of polyethylene insert (*Matsuda S, et al, Orthopedics, 1999*).

b) Decreasing lift-off motion

As lift-off motion of the femoral component possibly increases wear of the articular surface, it should be avoided after TKA. Joint laxity theoretically increases the risk of lift-off motion, but alignment is another important factor. Hamai et al evaluated the effect of static knee instability by stress radiography on dynamic lift-off motion in fluoroscopy; the static varus–valgus laxity on the stress radiograph did not influence lift-off. Moreover, 90% of their patients had neutral alignment (*Knee Surg Sports Traumatol Arthrosc, 2014*). We also evaluated effects of alignment and ligament balance on lift-off motion by using computer simulations, which have recently been used and validated in the field of TKA. We used KneeSIM software to evaluate effects of alignment and laxity on lift-off motion. Our result show that lift-off motion occurs with 5° varus alignment or with a combination of 2° varus deformity and 2 mm lateral laxity. However, no lift-off motion was detected in the knee with neutral to 1° varus malalignment even when the knees had 5 mm lateral laxity (*Kuriyama S, et al, Knee Surg Sports Traumatol Arthrosc, 2014*).

c) Acceptable postoperative symptoms

Nishida et al reported postoperative function with neutral alignment group was

better than mild valgus and severe varus group (*Knee Surg Sports Traumatol Arthrosc*, 2016). Our recent computer analysis also showed abnormal kinematics in the valgus-aligned knees. In our clinical survey, varus postoperative alignment negatively correlated with the satisfaction (*Matsuda S, et al, Clin Orthop Relat Res*, 2013).

3. Disadvantages of neutral alignment

a) Constitutional varus

Bellemans et al. report that the incidence of natural limb alignment of $\geq 3^\circ$ varus, which is termed constitutional varus, is approximately 32% in men and 17% in women (*Clin Orthop Relat Res*, 2012). They suggest that aiming for neutral alignment can result in overcorrection in some patients and report that patients with slight undercorrection have better function and pain scores than those with neutral alignment (Vanlommel L, et al, *Knee Surg Sports Traumatol Arthrosc*. 2013). Their cadaver study shows that restoration of constitutional alignment in TKA leads to more physiological strain in the collateral ligaments (Delpont H, et al, *Knee Surg Sports Traumatol Arthrosc*. 2014). However, there is no definite way to determine the degree of constitutional varus in a patient, and the “safe zone” of varus alignment is unknown. Some clinical studies reported that undercorrection does not worsen clinical results and that design modification can prevent wear problems even with malalignment. Nevertheless, concerns about tibial collapse in varus alignment remain.

b) Kinematic alignment

Howell et al. propose kinematic alignment as a way to maximally utilize ligamentous function. Better functional results were reported with kinematically aligned TKA than mechanical aligned TKA (Dossett HG, et al, *Bone Joint J*. 2014). Kinematically aligned TKA aims to reproduce the pre-osteoarthritic joint surface and does not align to any axis that has been used in the mechanical axis method. However, the precise pre-osteoarthritic morphology cannot be determined, and this technique incurs a risk of coronal malalignment, especially for patients with severe constitutional varus. Although these two new ideas have some unresolved problems, they pose the very interesting idea that postoperative knee function can be improved by preserving ligamentous tension rather than sticking to the mechanical alignment.