



# Less religion and more science in the discussion of personalized alignment in total knee arthroplasty: we need to lead the transition process!

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Personalized alignment in total knee arthroplasty (TKA) is a current hot topic in orthopedic surgery, which has been fostered by the introduction of different novel alignment techniques such as adjusted mechanical alignment, kinematic alignment (KA), phenotype alignment or functional alignment. Often KA is used as an umbrella term summarizing various approaches for a more individualized alignment, which is not appropriate and confusing to many surgeons. Kinematic alignment is one specific alignment technique aiming to restore the native pre-arthritic knee anatomy, but how can we define it? To provide physiological kinematics of the knee joint, KA aims to restore the native soft tissues tensions, which is in most cases a tighter medial

compartment and a looser flexion space [1, 7]. This contrasts with mechanical alignment (MA), where knee anatomy dependent from the phenotype might be altered with ligaments isometry being the goal throughout the whole arc of motion. KA can be achieved either using conventional instrumentation measuring the bone cuts or additional technology such as patient specific instrumentation (PSI), navigation or robots. One can differentiate the unrestricted from the restricted KA technique. The unrestricted KA technique puts no boundaries to the targeted resulting coronal alignment. The restricted KA technique as most of the more personalized alignment philosophies restricts the resulting coronal alignment to defined safe zones [11]. It was described by Vendittoli et al. and requires precision tools for patient anatomy determination and to perform alignment modification when patient' anatomy is outside the accepted safe zones [12].

Over the years there has been and still is increasing evidence generated about the value of KA in TKA [6]. However, the discussion which alignment target to choose and which alignment philosophy to follow somehow reminds us about discussions we had about single or double bundle (DB) anterior cruciate ligament (ACL) reconstruction. There were the early adopters, who were the first to apply DB ACL reconstruction on their patients with the benefit of being innovators and scientific influencers. However, there was a learning curve and their patients also experienced complications and failures like every innovation at early stage. The more conservative followers started with DB ACL reconstruction when they recognized that this technique was there to stay. It was the hottest topic at many congresses and meetings over a period of 5–10 years. A presentation of single bundle (SB) ACL reconstruction was hardly considered in any scientific program. Only few ACL surgeons resisted the constant pressure to switch to DB ACL reconstruction and kept their previous mostly

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SB anatomical ACL reconstruction techniques. Another major driving force was the industry, which were able to sell twice ACL fixation devices with DB techniques. Often the medtech industry is faster in developing and bringing new products to the surgeon than the still ongoing or just started scientific discourse. Then, the marketing machine is already rolling before the scientific discussions have settled and a sound consensus is not yet established. In ACL reconstructions the scientific discussion about DB or SB was an important one, but finally most of the surgeons have turned back to ACL SB reconstructions. The lasting clinical benefit of this discussion was not the discrimination between one or two bundles, but to focus on more anatomical positions. Future will tell the lasting benefits of KA, as minimizing anatomical bony modifications, preserving kinematic axes, and/or less soft tissue release might be such factors.

For the sake of our patients, it should be the highest priority to stay objective and base our decisions to switch to novel often more interesting techniques or methods only based on scientific evidence and not on personal feelings.

In real life it is never black or white and hence we like to highlight the importance of grey scales in the discussion about personalized knee surgery. This might complicate the discussion for some of us, but it is necessary not to skip important details. With every surgical technique there are limitations and shortcomings, which need to be more present and emphasized in our journals or at congresses. More importantly, unsolved issues and problems need to be outlined by the scientific community and academic focus should not only be on positive results or testing methods, which is known as publication bias or file-drawer effect. Finally, years after the first promising results had been published often the trace of a novel product or technique is lost. Interestingly the products are loudly introduced with a “big bang,” then fade away rather quietly. How comes?

To date, we are at the doorstep of a new era in TKA—the era of personalized surgery. One part of personalized surgery is the alignment target discussion, which has been fostered by the functional knee phenotype concept [3, 5]. Unrestricted KA is considered the purest form of phenotype restoration in TKA surgery [2, 4]. Whilst passionate KA surgeons, who favor this technique, underline its superiority in almost all their cases, the data published mainly deals with patients in the alignment corridor of plus/minus 5°. There are still several caveats, which should be outlined for those considering changing from mechanical to KA alignment in TKA:

1. Riviere et al. [10] published their algorithm for an optimal setting of indication and highlighted the limitations. Here, in particular patients with global hyperlaxity (recurvatum), severe fixed flexion contractures, severe bony defects preventing a KA reconstruction, or cases requiring diaphyseal implant fixation were noted.
2. More than ten years data of independent study groups are still pending. Such data are however necessary to estimate the safety and longevity of KA TKA. In the short term, radiostereophotometry (RSA) studies of a substantial number of KA TKAs performed on patients with more extreme deformity (e.g., > 5° HKA) would probably be useful to define safe alignment boundaries and indications for restricted KA TKA.
3. There is currently only a paucity of data and no scientific consensus on sagittal phenotypes of the knee joint, which should take a possible physiological extension deficit or hyperextension into account [1, 7]. Therefore, using the unrestricted KA technique [12], a preexisting extension deficit or hyperextension might remain. It is unclear if this alters survivorship or clinical outcome of TKA.
4. Surgeons have to be aware regarding the complex phenotypes of the knee joint’s native trochlea groove with respect to its medio-lateral positioning, which is relevant for the positioning of the prosthetic femoral component [1, 7]. Most of the TKA systems were originally designed for mechanical alignment, in which the femoral component is externally rotated using the measured resection technique or predominantly externally rotated using the gap balancing technique. Using these components with KA (neutral femoral rotation relative to the posterior condylar line) with a flush anterior femoral cut might under- or overstuff the native trochlea depending on the discordance between patient’s anatomy and the implant’s design, leading to a different cause of anterior knee pain [8, 9].
5. Some patients with more extreme native anatomical variants, which could be considered as a pathological deformity should be done with mechanical alignment goals [10].
6. One big unsolved issue is the fact that longitudinal studies investigating the coronal alignment from non-OA knees to OA knees are missing. The pertinent question how to define normality in joint orientation and lower limb alignment is unanswered. What is physiological, neutral, normal, abnormal or pathological?

In conclusion, it is safe to transition from mechanical alignment to a more personalized restricted alignment target, one of such is restricted KA. However, one needs to be fully aware of the individual knee phenotype and the restrictions and limitations of each alignment philosophy. Setting the perfect indication and execution of personalized alignment in TKA should follow a clear algorithm and pathway such as the one presented by Riviere et al. [10]. An adequate and thorough training with an expert knee surgeon with or

without a virtual training with digital simulation software should be mandatory for transitioning from traditional MA technique.

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