

Editorials from Experience

The Evaluation of a ChatGPT Article

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JOIE has asked ChatGPT to generate an editorial comparing mechanical vs. kinematic alignment. I was asked to write a human editorial, from my experience as one of the earliest adopters of kinematic alignment since 2007.

The following was produced by ChatGPT in answer to the question: "Compare mechanical vs. kinematic alignment in total knee arthroplasty"

MECHANICAL VS KINEMATIC ALIGNMENT

Knee replacement surgery is a common procedure used to alleviate pain and improve mobility in patients with severe knee osteoarthritis or other knee-related injuries. One of the most important decisions surgeons must make during this procedure is choosing between two alignment techniques: kinematic alignment and mechanical alignment

Both techniques have their benefits and drawbacks, and choosing the appropriate method can be critical to the success of the surgery.

Kinematic alignment is a newer technique that has gained popularity in recent years. The goal of kinematic alignment is to restore the natural alignment of the knee joint as closely as possible, allowing for a more natural feel and better range of motion post-surgery. This technique takes into account the unique anatomical features of the patient's knee joint and aims to restore the joint's natural balance and stability. Kinematic alignment uses advanced imaging techniques, such as MRI and CT scans, to create a three-dimensional model of the patient's knee joint, allowing the surgeon to precisely place the implant components.

On the other hand, mechanical alignment is a more traditional technique that has been used for decades. The goal of mechanical alignment is to align the knee joint components based on predetermined angles and measurements, regardless of the individual patient's anatomy. This technique is based on the assumption that there is a standard alignment that will work for most patients. Mechanical alignment typically involves cutting the bone to specific angles to achieve the desired alignment, followed by the placement of the implant components.

Both kinematic and mechanical alignment techniques have their advantages and disadvantages. Kinematic alignment offers the potential for a more natural feel and better range of motion post-surgery, as the surgeon aims to restore the knee joint's natural balance and stability. However, this technique is more complex and requires advanced imaging techniques, which can increase the cost of the procedure. In contrast, mechanical alignment is a more straightforward technique that has been used for decades

and is generally less expensive. However, this technique can result in an unnatural feel and reduced range of motion post-surgery, as the predetermined angles may not match the patient's unique anatomy.

Ultimately, the choice between kinematic and mechanical alignment will depend on the individual patient's needs and the surgeon's expertise.

Surgeons must carefully consider the patient's anatomy, the severity of the knee injury, and the patient's desired outcome before choosing the appropriate alignment technique. Both techniques have been shown to be effective in improving knee function and reducing pain, but the choice between the two will ultimately depend on the patient's individual circumstances.

In conclusion, the decision between kinematic and mechanical alignment in knee replacement surgery is a complex one that requires careful consideration of the patient's individual needs and the surgeon's expertise. Both techniques have their advantages and disadvantages, and the appropriate alignment technique will depend on the patient's anatomy and desired outcome. With advances in imaging technology and surgical techniques, both kinematic and mechanical alignment techniques continue to evolve, providing patients with better outcomes and improved quality of life.

COMMENTS BY AUTHOR OF THIS EDITORIAL

Artificial Intelligence (AI) is a young unregulated industry, like the wild wild west- but moving at Star Trek-like warp speeds- begging to be slowed down by regulations that don't exist. It seems to be generating as much excitement as fear as it dips its toes into every aspect of our lives that could depend on a decision-making algorithm.

AI holds the promise in medicine of solving more diverse and challenging tasks than just reading imaging studies or the world medical literature instantaneously- but that portrait is still being drawn.

JOIE has asked ChatGPT to generate an editorial comparing mechanical vs. kinematic alignment. This is what came back. Few realize

But the AI doesn't know what any of it means. These models work by predicting the most likely next word in a sentence. They haven't a clue whether something is correct

or false, but can confidently present information as true even when it is not.

I was asked to write a human editorial, from my experience as one of the earliest adopters of kinematic alignment since 2007.

First I will bullet point some errors in ChatGPT essay:

- Most surgeons don't make a binary alignment decision but will decide on some preferred surgical OR alignment technique that will result in a stable balanced knee with an acceptable alignment.
- KA is not a new technique, but developed in 2006, and built on earlier foundational principles published by Eckhoff, Hungerford and others.
- The goal of KA TKA is to restore the 3 natural kinematic axes of the knee which ideally will restore the patient's natural pre-arthritis joint line and alignment
- KA may use many techniques, including PSI, robots, computers or mechanical instruments and calipers to perform KA TKA. Advanced imaging is not necessary. (KA technique is not related to the hip or ankle position and actually does not need any imaging techniques let alone advanced ones. It is the thickness of the distal and posterior femoral resections which are computed using three ingredients which must match the component thickness: the thickness of the resected condyle, 2 mm for worn cartilage to expose bone and 1 mm for the kerf of the sawblade. The surgeon can resurface the pre-arthritis femur with the femoral component more accurately with manual instruments than robotics and the learning curve is short for the inexperienced surgeon.)
- KA follows a simplified surgical and anatomically logical technique, does not add additional costs and often lowers costs associated with TKA across the spectrum regardless of surgical techniques utilized.
- KA literature often confirms better patient satisfaction, less complications, and more rapid recovery.
- MA TKA techniques have not functionally evolved since initially described by Insall and Freeman. KA principles are fixed and described by Howell in 2006. What is evolving is a realization MA is no longer the gold standard.

MECHANICAL VS KINEMATIC ALIGNMENT TKA ARTHROPLASTY—HUMAN CREATED

The modern field of total knee arthroplasty began over 50 years ago. In the 1970s, the combined effect of FDA approval of cement for implant fixation (i.e., methylmethacrylate) and the availability of durable plastic as a tibial bearing (i.e., ultra-high molecular weight polyethylene) fostered innovation of knee replacement implant designs.

Pioneers in TKA, using primitive implant designs & imprecise instruments developed a standardized reproducible surgical technique to decrease pain, improve function and balance forces across the knee to prevent wear and extend the life of the prosthesis

Simultaneously, alignment evolved into two opposing and contentious philosophies, the anatomic approach and the mechanical alignment approach. The 'personalized' or 'anatomic' alignment philosophy proposed by David Hungerford, MD from Johns Hopkins University, should be considered the predecessor of calipered kinematically aligned total knee replacement. Hungerford developed universal instruments based on the concept of measured resection so that the bone and cartilage removed equaled the thickness of the components. Equal thickness set the components coincident to the patient's pre-arthritis joint lines and retained healthy ligaments, preserving the kinematics of the native knee. Restoring the patient's pre-arthritis joint lines, which co-aligns the three kinematic axes of the knee with the components' three rotational axes is the foundation of calipered kinematically aligned total knee replacement.

In contrast, the 'one size fits all' or mechanical alignment philosophy proposed by John Insall, MD and Michael Freeman MD ignores individual pre-arthritis alignment differences by cutting the femur and tibia at a right angle to the long axis of the femur and tibia in all knees. This approach of mechanical alignment involves establishing a rectangular-shaped extension and flexion spaces with medial and lateral gaps of equal laxity throughout the motion arc. Obtaining gaps of similar laxity often necessarily follows a complex matrix of healthy ligament releases with imprecise and non-reproducible techniques, which tightens and alters the patient's pre-arthritis flexion space. No mechanical alignment version co-aligns the components' three rotational axes with the kinematic axes. Functional results of mechanical alignment's multiple ligament releases and component deviations from the kinematic axes is a potential cause of pain, stiffness, instability and patient reported dissatisfaction.

The mechanical alignment philosophy, combined with newer implant designs and technologies proffering more accurate alignment, provided little improvement in patient satisfaction by the early 2000s, but remains a mainstay of teaching programs, and ingrained in orthopaedic surgeons for decades. A reset in alignment thinking was necessary. Pioneers in identifying the normal kinematic of the knee prompted a surgical epiphany in 2006, realizing that few patients naturally have a 0-degree MA, and normal knee kinematics have nothing to do with the hip or the ankle but have everything to do with 3 independent but intimately related axes of rotation of the knee.

Case-series from multiple skilled arthroplasty surgeons and international joint registries reported a level of dissatisfaction in one out of 5 patients with a mechanically aligned TKA, providing an impetus for a paradigm change in alignment philosophy. In 2006, the tenet of personalized surgery caused a paradigm shift away from mechanical alignment to calipered kinematically aligned total knee replacement. Dr. Howell, a professor of biomedical engineering and sports medicine surgeon, developed the kinematic alignment technique and the first commercially made patient-specific guides designed to assist the surgeon in setting the components coincident to the patient's pre-

arthritic joint lines. In 2007, communication of the clinical experience of early adopters persuaded over 300 surgeons to perform more than 20,000 kinematically aligned total knee replacements by 2011. Between 2011 and 2022, many worldwide studies reported kinematic alignment improves patient satisfaction, function, ease of recovery, soft tissue balance, flexion, and joint-line and limb alignment compared with mechanical alignment.

In summary MA TKA techniques have not functionally evolved since initially described by Insall and Freeman. Right angled femoral and tibial cuts and the idea of parallel and equal flexion extension spaces creating gap imbalances necessitating ligament releases. KA principles are fixed and described by Howell in 2006, to coalign the axes and joint lines of the components with the three kinematic axes and joint lines of the pre-arthritis knee, preserving native ligament laxities, which does not create gap imbalances or the need for ligament releases. What is evolving is a larger percentage of surgeons appropriately questioning the philos-

ophy of 'one size fits all' surgical TKA techniques for a diverse population, seeking to improve patient satisfaction and dipping their toes into the KA alignment philosophy and conjuring up a number of hybrid surgical techniques incorporating some but not all aspects of KA ; restrictive KA, inverse KA, functional alignment, etc which are not KA, but some deviation of MA, are not expected to reproduce KA results. The alignment debate will continue, and MA TKA as the gold standard and the concept of neutral aligning every TKA as dogma is no longer true. KA is conceptually offering a plausible and more logical alternative, fueling the debate. Quality unbiased patient outcome measures, in addition to surgeon's experience will provide clarity for the future.

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