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From fusion to dynamic fusion

Since the introduction of pedicle screw fixation for the treatment of spinal pathologies in the early 60's, posterior stabilization systems have gone through several phases.

At first, the most common instrumentation for stabilization of the spine was carried out by means of rigid plates: Roy-Camille or Steffee plates made out of stainless steel and dimensioned to resist in vivo forces that were insufficiently understood at the time when compared to the present knowledge of biomechanics. From this time on, spinal instrumentations have undergone many developments, and designs met various fates but eventually migrated toward rods for the most part when the technique of three-dimensional correction of deformities appeared in the 80's with the CD system.

Yet again, stainless steel remained king for a period of time, as it was then the most readily available material for implants, and together with the desire to correct and stabilize the spine such as to maintain correction and eliminate the need for corset, the instrumentations were designed to ensure a dramatic increase of segmental stiffness, i.e. decrease range of motion to the greatest extent possible. When titanium became of more common use, the decrease of stiffness induced by its lower Young modulus led engineers to keep rods as large as possible – i.e. a quarter inch (6.35 mm) or 6 mm. Eventually, for the sake of less invasiveness, the rod diameter decreased and 5.5 mm titanium rods are now standard.

However, in parallel to the common course of practice of stabilization of the spine, some pioneering surgeons and engineers came up with alternative perspectives on the treatment of spinal pathologies and especially those involving the degenerative cascade of the lumbar spine. Within about the same period of time, two alternative techniques came to light: semi-rigid fixation for fusion or soft stabilization for non-fusion. From a technical or engineering standpoint, they had a somewhat similar purpose: allow for stabilization of the degenerative spine while maintaining a certain amount of load sharing and therefore functionality of the remaining anatomical structures.

The concept of soft stabilization was pioneered with the Graf ligament, which is virtually no longer used, at least outside of Asia, and Dynesys®, which remains a fairly widespread instrumentation, and actually the only instrumentation of its kind with a significant clinical experience. The latter captured a lot of attention, as stabilization without fusion of the spine in early stages of the degenerative cascade appeared to be the preferred standard of care for many surgeons.

Unfortunately, while conceptually very appealing, the introduction of non-fusion technologies in the middle of an era of search for stiffness has also created some confusion and especially with regards to indications of choice for such instrumentations.

At the same time, another group of surgeons and engineers came up with the idea of keeping the ultimate objective of fusing the spine but using instrumentations featuring lower stiffness than with standard rod systems concurrently available. This concept of semi-rigid fixation would be the design principle leading to small diameter rod instrumentations – such as Twinflex® or Equation – or dampener-based control of stiffness – i.e. Isobar® Dynamic rod or Aladyn® Dynamic plates.

Many years later, while the understanding of the spinal biomechanics has made significant progress, it has become clear that instrumentation of lower stiffness meant for fusion actually involves the principles of Wolff's law, i.e. bone remodels such as to better cope with the applied loading and stresses induced thereby. It is based on this understanding that Scient'X has put forth the motto of Dynamic Fusion, in other words, lower stiffness dynamic instrumentation meant to facilitate bone remodeling in the course of graft consolidation and later on load sharing with the spine.

The articles featured in the following pages illustrate the technical concept of Dynamic Fusion through the clinical experience of surgeons who apply it in their daily practice of care. ●

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