E-MAG Active Justification over other KAFOs

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Knee-Ankle-Foot Orthoses (KAFOs) are medically indicated for patients that present with quadriceps weakness, absent knee extensors, or muscular sagittal plane instability to safely support body weight during ambulation. The prevalence of falling is significant among these patient populations due to compromise of the sensorimotor system, muscle weakness and reduced postural control or balance.[1]

The general purpose of a KAFO is to provide sagittal knee stability (=prevention of knee collapse) during stance, which is the weight-bearing phase of ambulation. Four types of KAFOs exist to assist individuals presenting with weak or absent quadriceps who wish to walk independently; 1) Locked Hinge, 2) Posterior Offset Knee Joint, 3) Stance Control, and 4) Microprocessor Stance and Swing Phase Control.

Locked Hinge KAFOs immobilize the knee joint at all times except when disengaged manually to permit knee flexion during sitting. This forces the patient to walk stiff-legged, using significant energy and compensatory movements, including hip hike (pelvic obliquity), circumduction (hip abduction), and vaulting (contralateral ankle plantar flexion in stance). These deviations induce significant energy expenditure, prematurely fatiguing the patient.[2,3,4]

Posterior Offset KAFOs allow flexion and extension to occur under certain conditions, which reduces compensatory movements, such as those required with Locked Hinge KAFOs. However, Posterior Offset KAFOs provide limited stance stability, and the more posterior the alignment is, the more difficult it is for the patient to initiate swing, which results in considerable gait inefficiency.

Stance Control KAFOs, also known as Stance Control Orthoses (SCOs), allow the knee joint to flex during swing phase but block flexion during stance, which is the weight bearing phase of the gait cycle. This action holds the knee in a safe and stable position while walking on the weak, braced leg. These mechanisms are designed to release the knee, allowing both flexion and extension during swing (the non-weight bearing phase of the gait cycle). Thus, a patient is afforded a faster, more normal and energy efficient gait.[4]

The E-MAG Active is an electronically controlled knee joint with a secure stance phase and free swing phase that is controlled independent of the ankle or sole of the foot. The E-MAG Active is designed for a Stance Control KAFO.

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The E-MAG Active electronics contain a gyroscope which monitors the angle of the femur as the patient walks. The gyroscope monitors the gait cycle and unlocks the knee joint at terminal stance and relocks at the end of swing to facilitate a more natural gait pattern. Since the electronic component measures gait independently from the ankle joint (or the foot sole), the patient does not require ankle range of motion to have functional stance control. For patients that have conditions of the ankle, the E-MAG Active can aid in more consistent unlocking of the joint.

It is the patient's clinical presentation that dictates whether they are an appropriate candidate for Stance Control. Quadriceps weakness is the primary indication. Patient groups include but are not limited to those with neuromuscular diseases such as poliomyelitis; post-polio-syndrome; incomplete paraplegics; muscle dystrophies, flaccid paresis or trauma to the knee extensors or nerves to the knee extensors.

The design of the E-MAG Active allows the user:

1. Secure stance phase to prevent falls when locked
2. Faster walking speed[4]
3. Free swing phase to eliminate hip hiking, pelvic obliquity, and vaulting[4],
4. Increased mobility for more community ambulation due to reduced metabolic energy expenditure[4]
5. A more physiological gait pattern leading to less stress to other body areas
6. Increased patient satisfaction[4]
7. Up to a 10 degree knee flexion contracture with dorsal stop at the ankle
8. Up to 15 degree knee valgum/varum
9. Stance control with no ankle range of motion.

Other stance control orthosis may require ankle range of motion to achieve stance control. Since the electronic activation is calibrated and can be recalibrated for changes in the user's gait, the E-MAG Active offers more consistent unlocking during variable step length than other stance control KAFOs.

[1]Lord SR, Allen GM, Williams P, Gandevia SC. Risk of falling: predictors based on reduced strength in persons previously affected by polio. Arch Phys Med Rehabil. 2002 Jun;83(6):757-63

[2]Irby SE, Kaufman KR, Mathewson JW, Sutherland DH. Automatic control design for a dynamic knee-brace system. IEEE Trans Rahbil Eng. 1999 Jun;7(2):135–139.

[3]Gross McMillan A, Kendrick K, Michael JW, Aronson J, Horton GW. Preliminary Evidence for Effectiveness of a Stance Control Orthosis, J Prosth Orthot. 2004;16(1):6-13.

[4]Zacharias B, Kannenberg A: Clinical benefits of stance control orthosis systems: An analysis of the scientific literature. J Prosth Orthot. 2012;24(1):2-7.