E-MAG Active

Biomechanics – Gait analysis

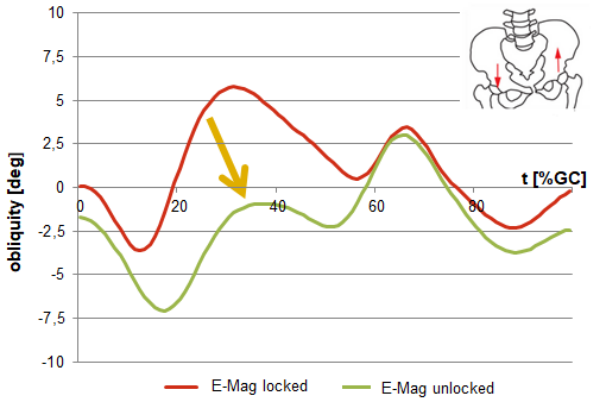
Major Findings

With E-MAG Active in unlocked mode (vs locked mode):

→ significantly increased walking speed (0.06m/s; p < 0.05)

→ anatomically normalized knee flexion angle (57° at 70% gait cycle)

→ significantly reduced hip hiking



Hip hiking reduced

6 out of 8 patients

Schröder et al., 2018

Clinical Relevance

Patients with total or partial weakness of knee extensors are usually fitted with a Knee Ankle Foot Orthoses (KAFO) with a manually locked knee joint that provides safety while walking and can be released for sitting down. Those orthoses restore basic walking capabilities but have considerable disadvantages compared to normal walking (Bernhardt et al. 2006; Irby et al., 2005; Schmalz et al, 2005). Patients with locked KAFOs depend on compensatory movements to avoid stumbles when walking, like hip hiking and vaulting (unnatural plantar flexion during mid-stance on the sound side) to provide sufficient toe clearance during swing (Zacharias et al., 2012).

Stance Control Orthoses (SCOs), like the E-MAG Active, were introduced to mitigate these limitations: they provide a locked knee stance, but enable free knee flexion during the swing phase. Furthermore, a natural gait pattern is pursued since it prevents the sound side from higher or inappropriate loads due to compensatory movements. Overloading of the sound limb can result in secondary diseases such as osteoarthritis.

Biomechanical 3D gait measurement is conducted to determine joint angles, moments and load on the joints, so that differences in gait patterns between locked KAFO and E-Mag Active can be determined objectively.

Summary

When walking with E-MAG Active, we found an average knee flexion angle of 57°± 15° during swing phase at about 70% of gait cycle, which is in line with the results of previous studies that found knee swing flexion angles between 29° and 65°

across their subject samples (Hebert et al., 2005; Irby et al., 2007; Moreno et al., 2008; Schmalz et al., 2005; Yakimovich et al., 2006; Zissimopoulos et al., 2007). Physiologically, humans walk with a knee flexion angle of about 65° between 40-75% of the gait cycle, representing an important contributor to sufficient toe clearance of the swinging leg (Götz-Neumann, 2006; Perry, 2003).

As the orthotic knee joint allows for bending and thus sufficient toe clearance during swing, compensatory movements may be substantially reduced: Lifting of the pelvis on the orthotic side may be diminished and untimely plantar flexion of the sound foot may be reduced.

Compensatory movements were reduced with E-MAG Active. Especially, hip hiking was reduced in 6 out of 8 subjects based on the angle of pelvis tilt (obliquity) in the coronal plane. Additionally, vaulting was reduced in 2 out of 3 subjects based on the sagittal angle and moment of the ankle. (Schröder et al., 2018)

These results are in accordance with previous studies. Zissimopoulos, et al. (2007) and Irby, et al. (2007) showed significantly reduced pelvic obliquity on the orthotic side with the SCO compared to a locked orthosis. Schmalz, et al. (2005) reported that the pelvic movement when walking with an SCO was comparable to that of healthy subjects. Irby, et al. (2007) described a significant reduction in vaulting of the sound side with an SCO, and Hebert & Liggins (2005) reported even no unnatural sound side plantar flexion at all in the middle of the stance phase.

SCOs, like E-MAG Active, show clear benefits over locked KAFOs, like greater toe clearance, more physiologic gait pattern, faster walking speed, lower metabolic energy consumption and reduced compensatory movements (Bernhardt et al. 2006; Davis et al., 2010; Irby et al., 2005; McMillan et al., 2004; Sabelis et al., 2007; Schmalz et al, 2005.

References of summarized studies

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