Agilium Freestep

Biomechanics – Gait analysis

Major Findings

With Agilium Freestep:

The knee adduction angular impulse is significantly reduced

→ Agilium Freestep in different adjustments: significant ($p<0.05$) decreased impulse in all conditions; by 5% in neutral position, by 3% in varus position, by 7% in valgus position (Fantini-Pagani et al. 2013)

The knee adduction moment (KAM, fist peak) is significantly reduced

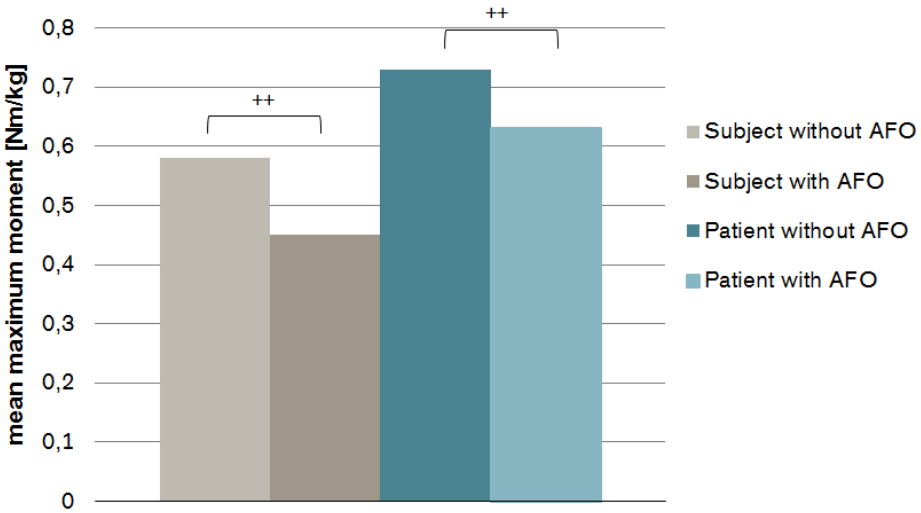
→ Patients: the KAM was reduced by 22% (Schmalz et al. 2011)
→ Subjects: the KAM was reduced by 11% to 20%
(Drewitz et al. 2017, Fantini-Pagani et al. 2013, Schmalz et al. 2011)

→ Agilium Freestep + 10mm shoe wedge: significant reduced KAM with both, medial and lateral shoe wedge (Schmalz et al. 2006)

→ Agilium Freestep + Insole: the KAM was reduced by 23% (Drewitz et al. 2017)

→ Agilium Freestep in different adjustments: significant ($p<0.05$) decreased KAM in all conditions; by 11% in neutral position, by 8% in varus position, by 12% in valgus position (Fantini-Pagani et al. 2013)

Mean Maximum knee adduction moment during walking



++ = significant changes between the conditions with / without Agilium Freestep for healthy subjects and patients with knee OA ($p \leq 0.01$)
[Schmalz et al. 2011]

Clinical Relevance

Osteoarthritis (OA) is a frequent cause of pain and disability in elderly people worldwide (Hinman et al. 2005) and its prevalence is expected to increase as the population ages (Ramsey et al. 2009).

The cause of OA is a non-physiological load distribution due to kinematic changes in the knee joint. A varus deformity of the leg axis leads to a long lever arm between the knee joint center and the vector of the ground reaction force, inducing a high external adduction moment. In the long term, these mechanisms can lead to damaged cartilage (Andriacci et al. 2004, Felson et al. 2009, Vincent et al. 2012).

Simply put, this means that the forces acting at the joint are high when the knee lever arm in the frontal plane is long due to varus malalignment. The length of the knee lever arm is correlated with a high knee adduction moment, and this adduction moment has been identified as the mechanism primarily responsible for a high compressive load in the knee (Ramsey et al. 2009).

The Agilium Freestep is used in unicompartimental OA. It is an AFO (ankle-foot-orthosis) that may reduce the eversion of the foot. Biomechanical studies showed that this shifts the vector of the ground reaction force closer to the center of the knee joint. As a result, the external adduction moment is reduced (Schmalz et al. 2006, Schmalz et al. 2011, Fantini-Pagani et al. 2013).

Summary

Four biomechanical studies have evaluated the effectiveness of the Agilium Freestep:

Schmalz et al. (2006) observed a significant reduction in the length of the knee lever arm to the vector of the ground reaction force (GRF) in the frontal plane and a significantly decreased knee adduction moment with Agilium Freestep in combination with shoe wedges.

Schmalz et al. (2011) investigated the Agilium Freestep without shoe wedges. Also here, a significantly reduced length of the knee lever arm to the GRF in the frontal plane and a significantly decreased knee adduction moment with Agilium Freestep could be shown.

Fantini-Pagani et al. (2013) conducted their study with subjects that showed a tendency towards a knee varus alignment. The former results could be confirmed. Significant reductions were seen in the knee lever arm, the knee adduction angular impulse and the knee adduction moment.

Drewitz et al. (2017) compared the effect of the Agilium Freestep to a combined use of Agilium Freestep with an insole as well as insoles without orthoses. The results showed that the orthosis reduced the knee adduction moment by 20% compared to no intervention. This effect could also be observed with the combination of orthosis and insole (reduction of 23%). An insole without orthosis increased the knee adduction moment by 1% compared to no intervention.

Thus, Agilium Freestep can alter the load distribution within the knee joint and thereby relieve the affected compartment. The use of this AFO, designed to offload the medial or lateral knee compartment, represents an alternative for conservative treatment of knee OA.

References of summarized studies

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Fantini-Pagani, C. H., Willwacher, S., Benker, R., Brüggemann, G.-P. (2013). Effect of an ankle-foot orthosis on knee joint mechanics: A novel conservative treatment for knee osteoarthritis. *Prosthetics & Orthotics International, 38(6)*: 481-491.

Schmalz, T., Blumentritt, S., Drewitz, H. (2011). Die Nutzung von Unterschenkelorthesen im Rahmen der konservativen Behandlung der Gonarthrose. The application of orthoses for the lower leg in conservative treatment of gonarthrosis. *MOT: Medizinisch Orthopädische Technik, 5*: 68-78.

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Other References

Andriacchi, T. P., Mündermann, A., Lane Smith, R., Alexander, E. J., Dyrby, C. O., & Koo, S. (2004). A Framework for the in Vivo Pathomechanics of Osteoarthritis at the Knee. *Annals of Biomedical Engineering, 32(3)*: 447–457.

Felson, D. T. (2009). Developments in the clinical understanding of osteoarthritis. *Arthritis Research & Therapy,* 11(1): 203-2013. DOI: 10.1186/ar2531.

Hinman, R. S., Crossley, K. M., McConnell, J., & Bennell, K. L. (2003). Efficacy of knee tape in the management of osteoarthritis of the knee: blinded randomized controlled trial. *BMJ: British Medical Journal*, *327(7407)*: 135-140. DOI: 10.1136/bmj.327.7407.135.

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Ramsey, D. K., & Russell, M. E. (2009). Unloader braces for medial compartment knee osteoarthritis: implications on mediating progression. *Sports Health, 8*: 416-426.

Vincent, K. R., Conrad, B. P., Fregly, B. J., & Vincent, H. K. (2012). The pathophysiology of osteoarthritis: a mechanical perspective on the knee joint. *PM&R: Physical Medicine and Rehabilitation, 4(5)*: S3-9. DOI: 10.1016/j.pmrj.2012.01.020.