Study copy with selected results

Inhibition of soleus Hoffmann reflex by ankle-foot orthosis application in healthy volunteers

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Prosthet Orthot Int 2014, in press; DOI: 10.1177/0309364614535621

Background

One of the intended functions of the ankle-foot orthosis used in this study is to stabilize the ankle mechanically. Another suggested function is that it also actively assists dorsiflexion of the foot by induction of a positive proprioceptive impact to the relevant muscles. However, there is still no proof yet for this neuromodulatory effect. The proprioceptive impact of external factors may also be determined using the Hoffmann reflex (H-reflex). The objective of this study was to determine the proprioceptive impact of an ankle-foot orthosis application by Hoffmann reflex recordings of the soleus muscle under static conditions. It was assumed that the use of an ankle-foot orthosis would facilitate dorsiflexor motor function and would thus decrease the soleus H-reflex.

Study design

Experimental study in healthy volunteers, pre-post test design

The study comprises three experiments: two preparatory and one main experiment. The first preliminary experiment investigates the H-reflex in terms of the agonistic and antagonistic pre-activation of the soleus muscle. The second preliminary experiment focuses on the proprioceptive character of two different orthosis types, measured using the H-reflex. The main experiment's purpose is to measure quantitatively the proprioceptive effect of an ankle orthosis. The relevant orthosis to be used for the main experiment was selected on the basis of the results from the second preliminary experiment.

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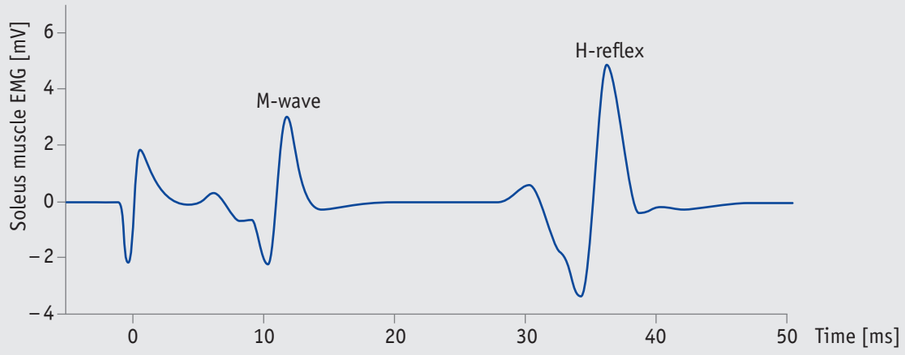
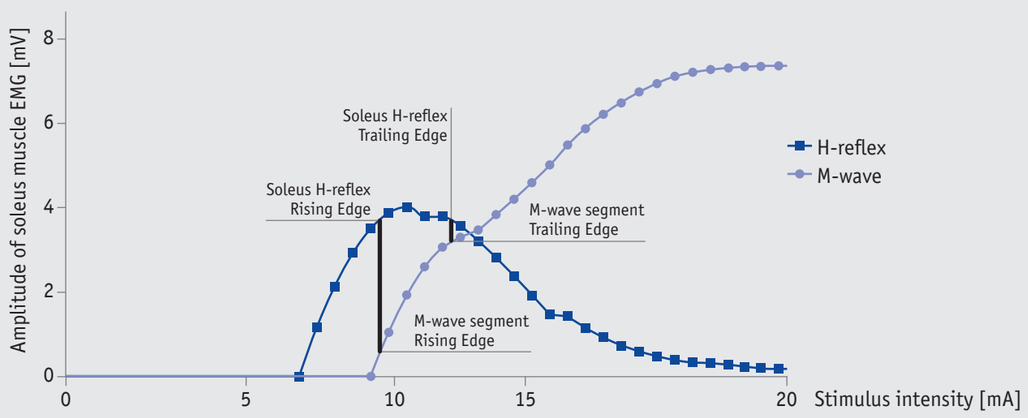
Methods

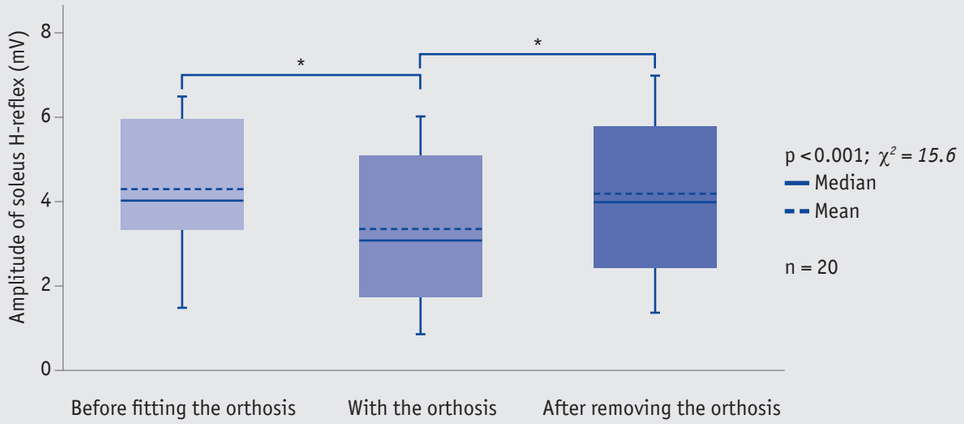
Sample: n = 20 (10 f, 10 m), age: 22.8 ± 1.7 (standard deviation) years
Test orthosis: Prototype of an ankle-foot orthosis from Bauerfeind
Test method: Pre-post test design: H-reflex measurements were taken before, during and after wearing the orthosis. Each measurement lasted 100 ms and started 20 ms before applying the stimulus
Data analysis: Analysis of variance (ANOVA),
Student-Newman-Keuls test for downstream, individual group comparisons (post-hoc-test),
significance level for all tests: 5 percent,
represented as one of three significance levels: $p < 0.05$, $p < 0.01$, $p < 0.001$

The study examines the proprioceptive impact of an ankle orthosis on plantar flexion (soleus muscle) and dorsiflexion (tibialis anterior muscle), measured by means of the agonistic or antagonistic pre-activation of the soleus muscle via the H-reflex.
It is assumed that pre-activating the soleus muscle, acting as an agonist, to a small extent, reinforces the H-reflex, while pre-activating the tibialis anterior muscles, acting as an antagonist, to a small extent, inhibits the muscle's H-reflex. Both of these hypotheses are crucial in assessing the proprioceptive impact of an ankle orthosis on the soleus H-reflex.





Results (selection)



** p < 0.05; χ^2: Test statistic from the Friedman Repeated Measures ANOVA for non-parametrically distributed data*

H-reflex measurement results
The boxplot shows the results for the H-reflex measurements for all 20 volunteers during the three experimental phases: before, during and after wearing the orthosis. The measurements when the orthosis was fitted gave significantly lower values than the measurements before and after wearing it.

Medial views

View from below

Orthosis used
The figure shows the Bauerfeind ankle-foot orthosis used during the experiment from four different angles. Wearing the orthosis resulted in a significantly lower soleus H-reflex in the experiment.

Discussion

Orthoses are generally used to stabilize joints passively in a mechanical manner. However, this study showed that wearing an ankle-foot orthosis decreases the H-reflex. Given the well-documented antagonistic relationship between the soleus and tibialis anterior muscles, this seems to suggest a boost in the motor function of the muscles used in dorsiflexion, particularly of the tibialis anterior muscle. These results may also suggest an additional active impact on the ankle joint's proprioceptive control. This kind of neuromodulatory effect on motor control supports the application of such ankle-foot orthoses in, for example, the treatment of drop foot or an ankle injury. Similar results suggesting that orthoses might also have an impact on proprioceptive mechanisms through mechanical stabilization are already known from studies involving knee and pelvic orthoses. There also seems to be a general impact in this case that can be achieved through using appropriate orthoses, benefiting those affected. However, it must be noted that the data recorded in this study for healthy volunteers under acute conditions is only applicable, to a certain degree, to chronic disorders.

Conclusion

The putative neuromodulatory effects favor treatment involving such an ankle-foot orthosis for indications such as drop foot or supination trauma.
Furthermore, it must be stated that the H-reflex is a suitable objective parameter for examining the neurophysiological features of ankle orthoses.