INDIVIDUAL CHANGES IN GAIT DUE TO EXPERIMENTAL PAIN

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Summary

This study evaluated gait patterns in healthy participants before and during the effects of experimental infrapatellar fat pad pain. Minor differences in kinetics and kinematics were observed comparing the baseline to the experimental pain gait. However, intra-participant changes were consistent.

Introduction

Pain can significantly influence how we move, though the exact mechanisms remain heavily debated. As a complex phenomenon, pain is often accompanied by confounding factors such as muscle weakness. Experimental pain models in healthy participants help isolate the direct effects of pain. However, many studies investigating pain's impact on gait have primarily focused on discrete kinematic or kinetic values instead of examining gait waveform data. Therefore, this study aimed to characterize how experimental knee pain in healthy participants influences the gait pattern using a non-directed hypothesis, examining the differences in the waveforms directly.

Methods

Thirty-four healthy individuals aged 27 ± 5 years, with BMIs 24.3 ± 3.6, of which 21 were male, participated in the study. Participants gave consent after being informed about the procedure and their GDPR rights.

Fifty-six reflective markers were tracked using a 12-camera infrared system [Qualisys, Sweden] as participants walked naturally over force plates [AMTI, USA], recording ground reaction forces. Five gait cycles were recorded per participant and condition (baseline and painful). Experimental pain was induced with injections of 0.25 mL, 7% saline (hypertonic) solution into the infrapatellar fat pad (IFFP). The participants evaluated their pain on a 0-to-100 scale (0: no pain, 100: worst pain imaginable) every 30 seconds.

Gait analysis was performed using the participant-scaled, lower-body model presented in [1] using the AnyBody Modelling System [AnyBody Technology, Denmark]. Waveforms of single participants were averaged and compared across conditions with paired t-tests ($\alpha = 0.05$) using spm1D [`spm1d.org`], the Statistical Parametric Mapping software for Python.

The study was registered at clinicaltrials.gov (NCT06330402).

Results and Discussion

Pain ratings increased after the injection until a peak of approximately 58 ± 22 after 3.5 minutes. A slower decrease followed until 10 ± 10 (skewed towards 0) after 10.5 minutes. Only three participants had pain after 15 minutes.

Knee flexion moment (KFM) is used to illustrate the results. No clinically relevant, statistically significant difference was found when comparing painful and baseline conditions, which show similar group-averaged KFM values

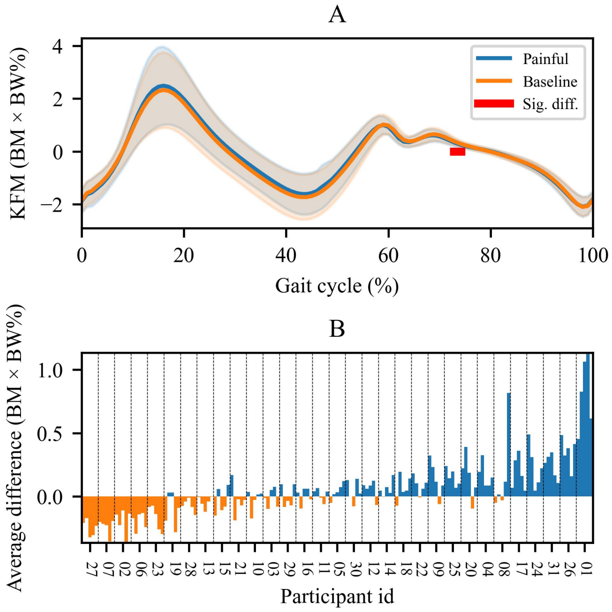

Figure 1: A: Mean KFM with $\pm$ standard deviation in shaded area, for the painful and baseline conditions. B: Differences in KFM by trial and participant, averaged across the gait cycle. Both y-axes expressed in percentages of body-weight times body-height.

across the gait cycle (Figure 1A) except for a small difference after the second peak.

However, this does not necessarily imply that pain has no effect or that its effect is completely random, as one can find structure beyond the mean and standard deviation shown in the plot (Figure 1A). The time-averaged differences in KFM (Figure 1B) show that a) changes are mostly consistent within participants, i.e., an individual is likely to either increase or decrease KFM and b) that the distribution is slightly skewed, with a greater fraction of people showing smaller decreases in KFM.

Conclusions

The painful injection of hypertonic saline into the IFFP did not introduce relevant, significant kinetic or kinematic changes on a group level. However, consistent changes might occur within participants, suggesting individual responses to the painful stimulus. Further efforts are needed to characterize and understand these individual responses.

Acknowledgments

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References

[1] Lund ME et al. (2012). *Proc. Inst. Mech. Eng. H*, **226(2)**: 82-94.