Gait Force Assessment and Analysis

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Abstract

Motivation: Knee osteoarthritis is a debilitating condition which may progressively lead to disability. Some medications may slow the development of arthritis, but there is no approved cure for the condition. Physical therapy presents an opportunity to reduce force on the knee, delaying the onset of osteoarthritis.
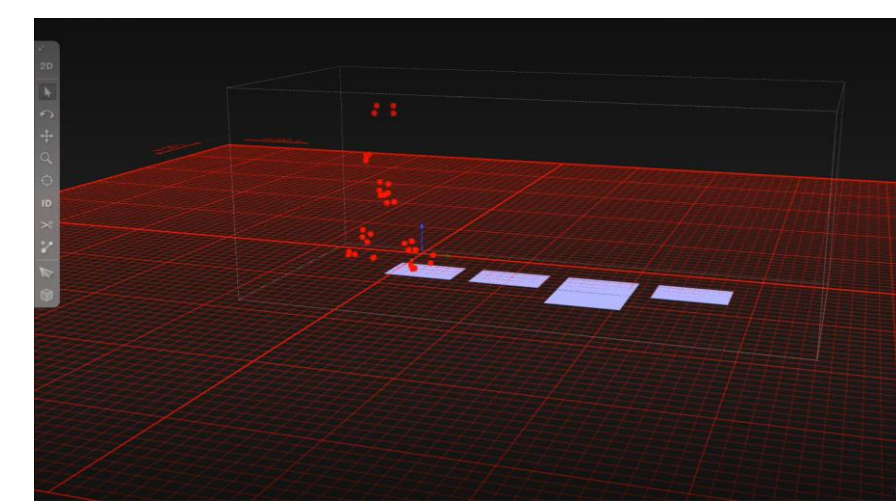
Personal Objectives: Automate data processing and graphing. Draw conclusions from graphs to determine if the physical therapy treatment was effective.

Results: Loads on the knee were inconsistent after therapy in test group participants. Some control group participants demonstrated patterns similar to test group participants.
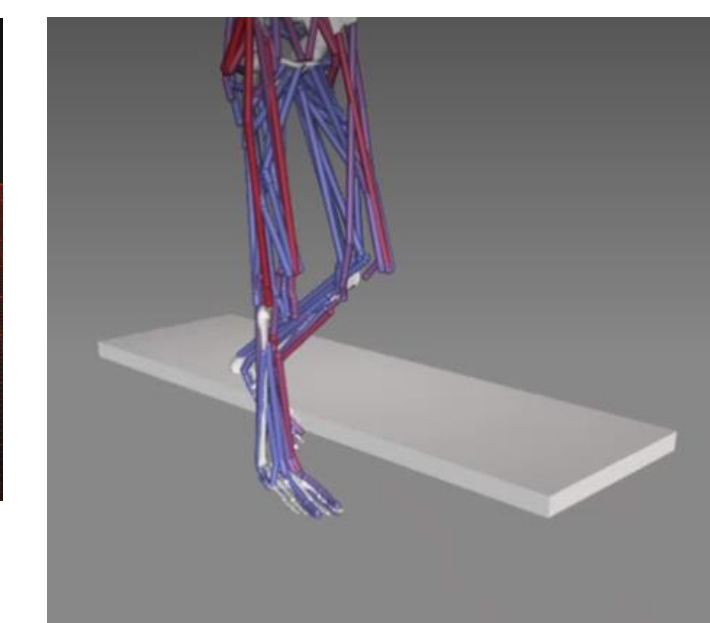
Experimental Methods

Data collection → Visual3D Computer Model → OpenSim Force Computation → MATLAB Data Processing & Graphing → SPM1D Statistical Analysis
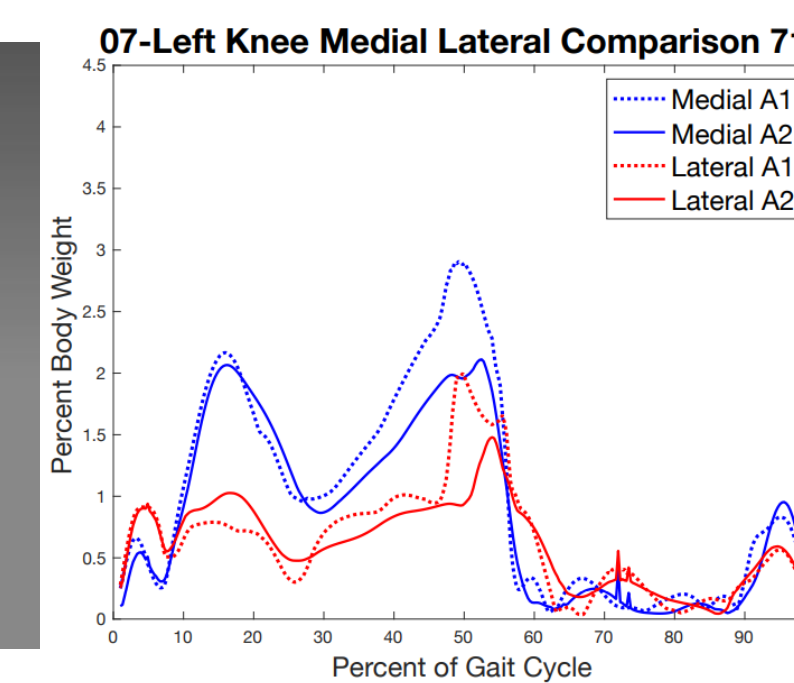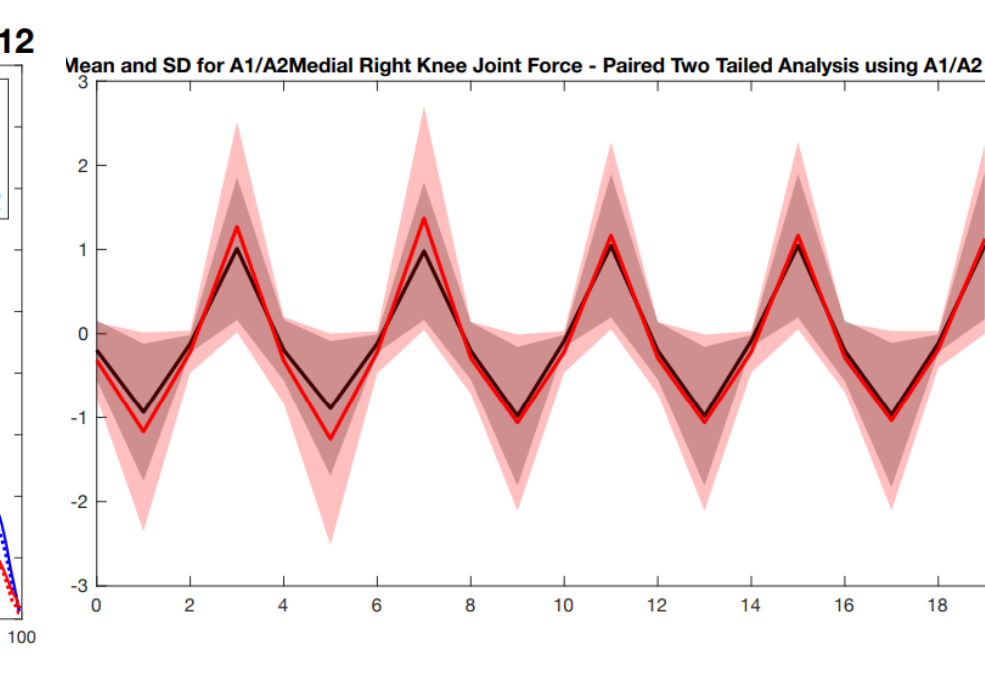

Data collection using force plates and cameras

Visual3D analysis of data points on participants to create 3D computer model.

OpenSim analysis of Visual3D models to calculate forces on each independent muscle group.

Data processing using MATLAB. Plotting the processed data using MATLAB.

Statistical analysis of the data using SPM1D and MATLAB.

Conclusion and Future Steps

While some participants in the test group reduced force during gait after therapy, other participants in the test group had no change or even worsened. This, combined with the fact that some control group participants also reduced load on the knee during gait, suggests that the therapy was ineffective.

The inconsistency of the results in the test group means that the particilar method used in the test group cannot be claimed as effective in reducing knee joint forces.
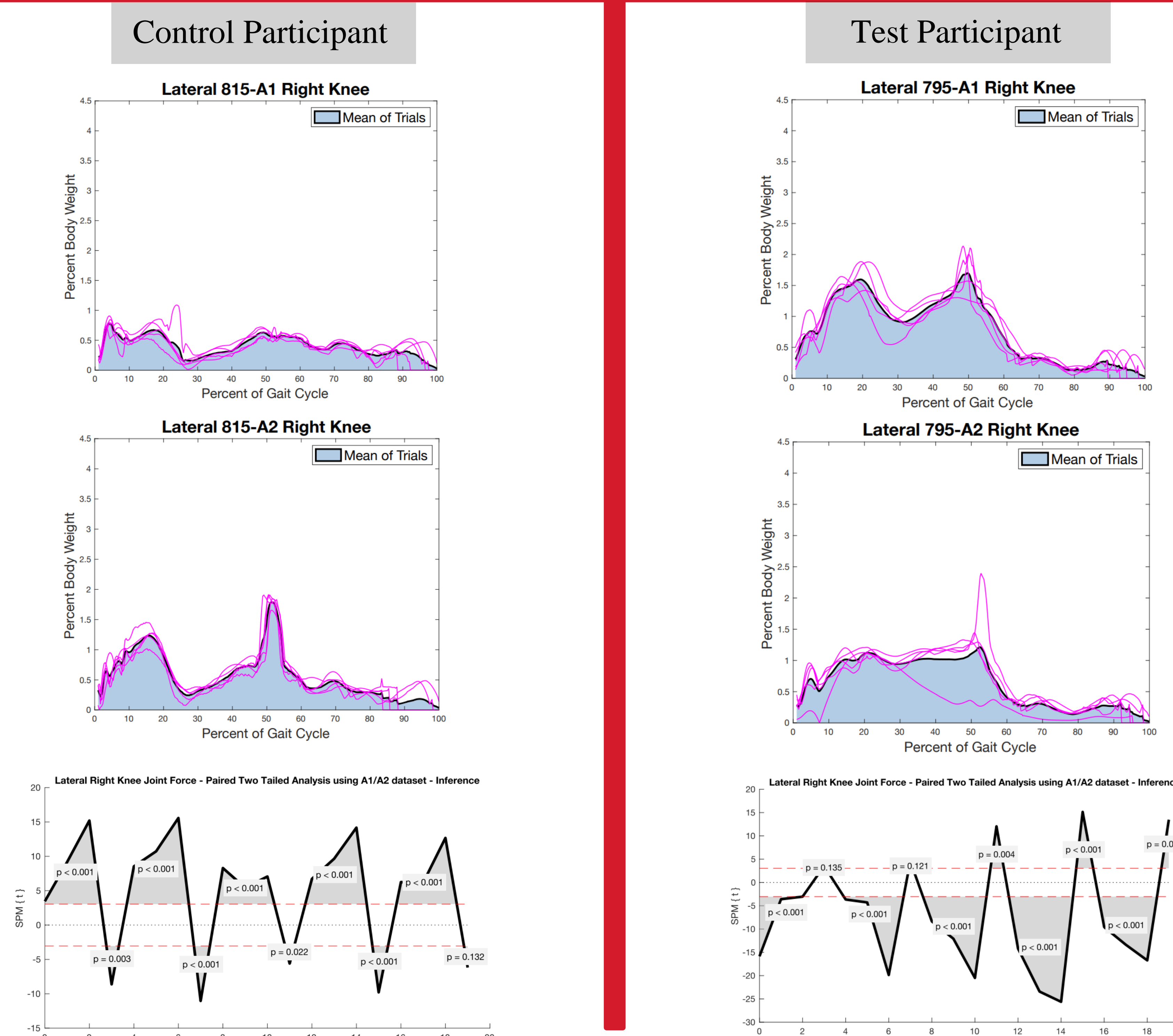
Background

Over a third of people over 65 have knee osteoarthritis. This condition is characterized by the degradation of cartiledge between the femur and tibia during aging. Knee osteoarthritis can cause pain while walking, sitting, or laying down, as well as reduce mobility. Currently, common treatments are exercise, weight loss, topical NSAIDs, etc. Opiods are also becoming increasingly more common to treat osteoarthritis, however these drugs can present harmful side effects.

Figure 1. A normal knee joint (side view). Figure 2. A knee joint with osteoarthritis.
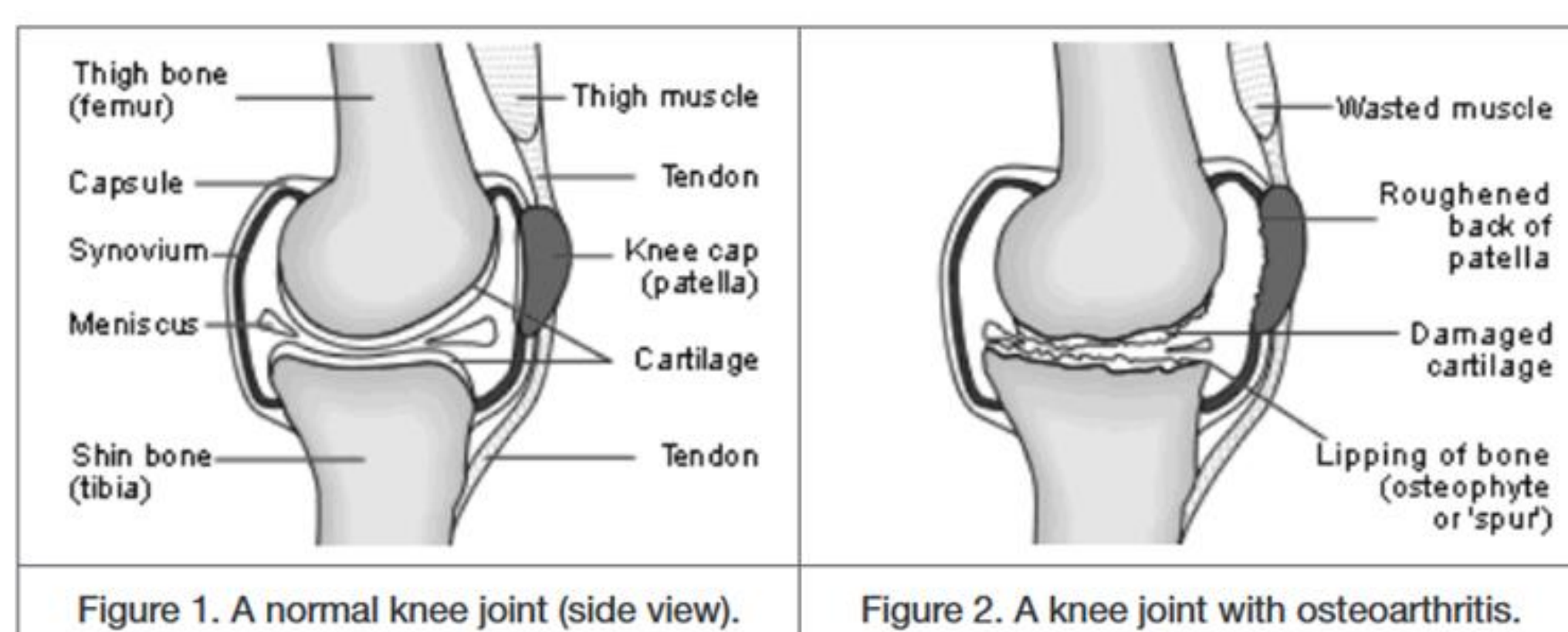
A comparison between a healthy knee (left) and arthritic knee(right). The cartilage is worn away on the right knee, causing painful contact between bones.

Our research aims to determine whether gait retraining is an effective method to reduce knee joint forces. Gait retraining is a relatively uninvasive method with no known side effects.

Results

Control Participant

Lateral 815-A1 Right Knee

Lateral 815-A2 Right Knee

Lateral Right Knee Joint Force - Paired Two Tailed Analysis using A1/A2 dataset - Inference

Test Participant

Lateral 795-A1 Right Knee

Lateral 795-A2 Right Knee

Lateral Right Knee Joint Force - Paired Two Tailed Analysis using A1/A2 dataset - Inference

References

Hsu, H., & Siwiec, R. M. (2022). Knee osteoarthritis. In *StatPearls*. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK507884/

Ringdahl, E., & Pandit, S. (2011). Treatment of knee osteoarthritis. *American Family Physician*, *83*(11), 1287–1292. https://www.aafp.org/pubs/afp/issues/2011/0601/p1287.html

Acknowledgements