EVALUATION OF A PATIENT-SPECIFIC COST FUNCTION TO PREDICT THE INFLUENCE OF FOOT PATH ON THE KNEE ADDUCTION TORQUE DURING GAIT*

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A large external knee adduction torque during gait has been correlated with the progression of knee osteoarthritis (OA). Though foot path changes (e.g., toeing out) can reduce the adduction torque, no method currently exists to predict changes that will yield the greatest reductions. This study evaluates a patient-specific optimization cost function to predict how foot path influences both adduction torque peaks. Video motion and ground reaction data were collected from a patient performing normal, toe out, and wide stance gait. Joint and inertial parameters in a dynamic, 27 degree-of-freedom full-body gait model were calibrated to the normal gait data. The model was used in subsequent gait optimizations that predicted the toe out and wide stance adduction torque peaks starting from the normal gait data. The cost function was composed of a weighted sum of squares of errors for foot path, trunk orientation, center of pressure, joint torques, joint angles, and ground reaction forces. Errors were computed relative to the normal gait data except for foot path and center of pressure, which were adjusted to match the increased toe out angle or stance width measured experimentally. Values for the cost function weights were determined via two-level optimization. The outer level minimized errors in the adduction torque peaks by varying the cost function weights used in the inner level. The weights were calibrated to the toe out gait data and tested using the wide stance gait data. After calibration, the toe out optimization correctly predicted a significant reduction in only the second peak. Using the same weights, the wide stance optimization correctly predicted a significant reduction in both peaks. For both optimizations, predicted peaks were within 10% of their experimental values. The next step will be to predict whether an optimal foot path exists that minimizes both adduction torque peaks simultaneously.

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