

---

## Project Overview: Evaluation of a Microprocessor-Controlled Knee Joint for an Above Knee Prosthesis

The objective of this study is to evaluate the benefits offered to above-knee amputees by a recently developed electro-mechanical knee joint incorporating a microprocessor-controlled pneumatic valve. The study will compare and contrast the function of the "intelligent" knee joint with that of a conventional mechanical knee joint typically worn by amputees, in terms of gait characteristics. This will allow assessment of the increased functionality provided by the intelligent system, the effective independence of the amputee, the amputee groups most likely to benefit from such a system, and the measure of cost/benefit of the new system.

It is hypothesized that a recently developed electro-mechanical knee joint has the potential to improve the function of an above-knee prosthesis and hence increase the independence of the amputee to the extent that the additional cost of the prosthesis is justified.

In order to evaluate the improved effectiveness of the prosthesis, data collection will take place while subjects wear each of the two prostheses. Prior to testing, they will participate in a training session describing the tasks to be accomplished (walking on a treadmill, walking uphill or downhill, ascending and descending stairs, walking across a force platform). They will then return on two separate occasions for the full test protocol to be performed with each of the two prostheses.

They will be fitted with their new prosthesis by a certified prosthetist and will undergo one month of training and acclimatization with this prosthesis. During this training period, return visits may be made to the clinic for adjustments of the microprocessor settings. Following testing with either of the two prostheses, they will be given one month of acclimatization and training with the alternate prosthesis. After this acclimatization, the experimental protocol will be completed as before.

Subjects will be asked to walk on a treadmill for a period of 10 minutes during which the walking speed will be gradually incremented from slow (~1 km/hr) to fast (~5 km/hr). The exact settings and the range of speeds will be varied according to the subject's ability, estimated in the training session. During the walking sequence they will wear a mouthpiece and headset so that respiratory gas exchange may be collected. Three self adhesive electrodes will be attached to their torso so that heart rate may be monitored. In addition, small accelerometers, goniometers and foot switches will be taped to their lower limbs so that we may measure limb motion.

Following a ten minute rest period, they will be asked to walk uphill on the treadmill adjusted to a slope of 1 in 10 (~6°). The same experimental protocol and data collection will be observed as in level walking with the maximum uphill walking speed reduced to approximately 3 km/hr.

They will then be tested for their ability to ascend and descend stairs and to walk on sloped terrain. For this portion of the study, limb motion will be measured using accelerometers and goniometers as described above.

Subjects will then be asked to walk across the force platform in order to measure ground-foot reaction forces. They will walk across the force platform at 3 speeds: slow (~1 km/hr), normal (~3 km/hr) and fast (~5 km/hr) in each direction. For this portion of the study subjects will have several small markers taped to their lower limbs and the recorded limb motion

---

will be synchronized with the forces between the body and the ground. During testing, subjects will wear shorts and a T-shirt. All equipment will be positioned and secured so that it will not affect their performance. In addition, throughout the study, subjects will be asked to provide researchers with subjective feedback on their fatigue level and satisfaction with the prostheses.

**Benefits:**

Objective indications that the new (Blatchford) prosthesis does or does not provide improved functionality for the amputee will benefit both health care professionals and amputees. Currently, due to a lack of objective evidence, funding agencies are reluctant to bear the added cost of providing amputees with the new microprocessor-controlled prosthesis as opposed to a conventional design. Once a qualitative evaluation is complete and results have been disseminated, health agencies will then have the cost-benefit data necessary in order to make informed decisions on whether to support the fitting of a microprocessor-controlled prosthesis.