Mechanical Orthosis Mechanism to facilitate the Extension of the Leg

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INTRODUCTION
In the United States, there are 282,000 persons living with a spinal cord injury, with approximately 17,000 new cases every year (54 per million persons) [1]. The main limitation that people living with paraplegia report is being unable to walk; they also feel social pressure for standing up and walking [2]. Over the last years, many assistive technologies were developed to help people living with spinal cord injury stand and walk. The mechanical orthoses are the ones mostly used in practice. With some of the mechanical devices such as the knee-ankle-foot orthosis and the reciprocating gait orthosis, users need to extend the leg straight to lock the orthosis’s knee joint. When the orthosis’s knee joint is locked, the orthosis supports the leg so the user can stand and walk. The challenge is that the orthosis needs to be extended manually by the user to lock the mechanism, which is constraining and non-ergonomic as it requires flexibility. This may cause difficulties to some users [2].

OBJECTIVES
The objective is to modify the design of a mechanical orthosis to help users extend the leg and lock the knee in a fully extended position. The new mechanism should fit on different orthoses that have a lockable knee joint. This joint can have curves in the sagittal plane.

RESULTS
The final mechanism is a lever arm attached below the knee joint. It can be folded when it is not used.

Mechanism in the folded position. The lever arm is closed to the orthosis. The dark grey part represented the orthosis, just below the knee joint. The blue grey section is the one designed to link the final light grey foldable mechanism to the orthosis.

Mechanism in the unfolded position. The lever arm is extended to help locking the knee joint.

Top line: steps to extend the leg without the device
i) The foot is placed on the ground, not on the foot support of the wheelchair,
ii) Pulling from the strap, close to the knee joint,
iii) Pushing on the thigh when the leg is almost in full extension,
iv) Leg in full extension
Time to extend the leg without the device: 30 seconds to 4 minutes

Bottom line: steps to extend the leg with the mechanism presented
i) The foot is placed on the ground, not on the foot support of the wheelchair,
ii) Pulling on the lever arm,
iii) Leg in extension
Time to extend the leg with the device: 4 seconds

User opinion:
The new mechanism is simple but effective, and less demanding.

DISCUSSION AND CONCLUSION
The mechanism allows the user to lock the joint of the orthosis while transforming a mainly parallel force to a mainly perpendicular force at the pivot point at the knee. A preliminary test indicates that the objective was met for this person but should be tested with other orthosis users. The mechanism is designed for a knee-ankle-foot orthosis, but could easily be transferred to any other type of mechanical orthosis. Minor modifications can be made to the design to fit on other types of orthoses. Future versions of the mechanism could include a means to adjust the anchor on the orthosis in the transverse plane. Currently, the user can only adjust the orthosis in the sagittal plane. This latter modification would allow the mechanism to fit on more complex types of orthoses. The design is promising for persons who use mechanical orthoses to extend their knees in order to stand and walk. The mechanism requires less strength and the design makes it small and simple to use.

REFERENCES

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