Overcoming brachial plexus injuries using a passive orthosis

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Brachial plexus injuries (BPI) typically caused by trauma, birth complications, inflammation processes and even tumours result in total or partial paralysis of upper limbs due to the lesion of some neural pathways such as the cervical C5-C8 and thoracic T1 nerve roots [1]. Among adult traumatic BPI, motorcycle accidents represent the overwhelming majority cause, mainly involving male subjects below the age of 30 [2]. As with some neuromuscular diseases, these injuries reflect residual or absence of muscular activity.

The gravity balancing principle [3] states that it is possible to counteract the gravitational force (i.e. to compensate weight) using only passive linear elastic elements such as springs. Thus, a mechanism designed this way is able to maintain its position in any possible configuration.

Selection of C7 nerve root lesion as study case:
- all pre-load lengths of five springs are set to $l_{pre}=0.06$ m;
- optimal spring stiffness $k_{opt}= [1473.4,0.3,0.03,102.0,1979.0]$ N/m;
- glenohumeral joint is only supported by cable 1;
- motion is restored when wearing the orthosis.

In addiction to this proof-of-concept, experimental validation is required. A patient-specific musculoskeletal model can be used to optimise a patient specific orthosis for essential activities of the daily living. Both wearability and aesthetics of the current design must be improved using light-weight materials and 3d-printing.