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Biomedical and Electrical Engineering
BME 482

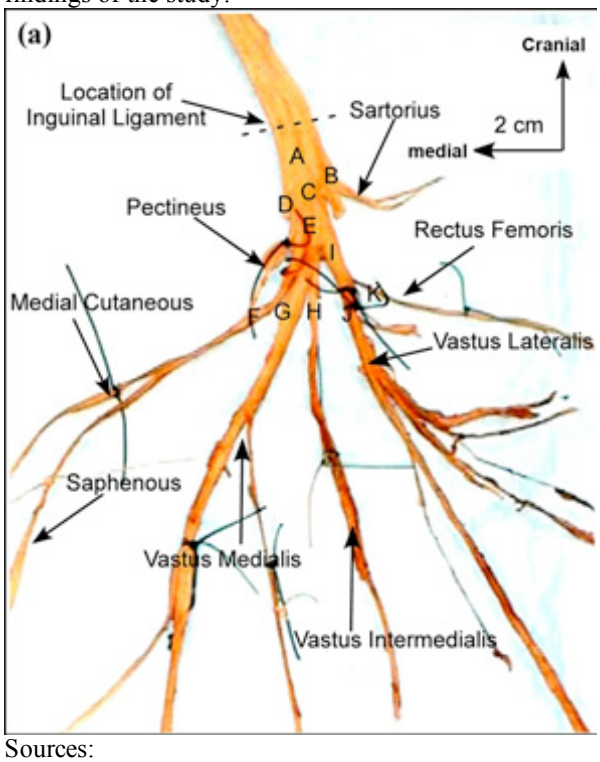
Fascicular anatomy of the Human Femoral Nerve: Implications for Neural Prostheses Using Nerve Cuff Electrodes

Spinal cord injuries are very debilitating afflictions that affect many people throughout the world. Throughout human history once sustaining a serious spinal cord injury victims would be forced to live with their injuries for the remainder of their life. In recent times treatments have been developed and progressed in order to heal victims of their injuries and restore function to parts of their bodies which had formerly been rendered useless. The most promising method to date involves the use of electrodes as a means of bypassing the damaged spinal cord and allowing the passage of nerve signals to muscles in areas previously unreachable due to the injury.

The most prominent process of accomplishing this presently involves the connection of electrodes to the nerve entry point on a muscle or intramuscular electrodes inserted in to the muscle belly. Each of these methods are very invasive and require numerous surgeries. As an example the primary muscles used in the process of standing up from a sitting position are the sartorius and the rectus femoris. Upon reaching the standing position the vastus lateralis, intermedius, and medialis take over and allow you to remain in the standing position. By using electrodes that are connected to each individual muscle in one leg alone you already have five separate electrodes that need to be surgically installed into your body. In addition to this muscle based electrodes can also continue to innervate muscles even when the result is not desired anymore. An example is once reaching the standing position they continue to innervate the sartorius and rectus femoris muscles. This would cause the muscles to tire more quickly and decrease the amount of time spent standing and also decrease the distance the patient could walk.

The solution to this problem is the use of nerve cuff electrodes. These electrodes are connected to a major nerve such as the femoral nerve. From there electrical impulses can travel down the femoral nerve and to each of its branches. This would minimize the amount of electrodes needed to be implanted from five to one when comparing to muscle based electrodes. In order for these electrodes to correctly function a fully developed network of fascicles must be present from nerve to muscle. The main point of this study was to determine how many fascicles exist and how they are most likely arranged in humans. This in turn could then allow for studies using nerve cuff electrodes as a means for healing patients with spinal cord injuries.

The study was done on four female cadavers and six males whom were having surgery on their thigh and allowed the study to be done. The findings were for the most part identical throughout each specimen in terms of order and location of branches of the femoral nerve. Also the size of the nerves were all very similar. The most important finding of the study was that there were enough fascicles in each specimen studied to allow for the use of nerve cuff electrodes. In addition to this the findings regarding order and location of the nerves matched that which previous studies have confirmed which reiterates the structure of the human body. This shows that the nerve cuff electrodes should be able to be used in the majority of people if needed. Shown below is a picture of the left femoral verve and its branches coinciding with the findings of the study.



Sources:
Gustafson, Kenneth, Gilles Pinault, Jennifer Neville, Ishaq Syed, and John Davis. "Fascicular Anatomy of the Femoral Nerve: Implications for Neural Prostheses Using Nerve Cuff Electrodes." Journal of Rehabilitation Research & Development 46. (2009): 973-984. Web. 1 Feb 2010. <http://www.rehab.research.va.gov/jour/09/46/7/Gustafson.html>.

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