PATTERNS OF HAND MOTOR DYSFUNCTION IN BRAIN INJURY

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INTRODUCTION

Activities of daily living (ADLs) involve smooth voluntary movements between joints that require a synchronized recruitment of relevant muscles. Motion is thus realized by a balance in directional preference of muscular activity. Upper motorneuron syndrome (UMNS) due to lesions in cortico-spinal pathways is common following a stroke or traumatic brain injury. UMNS manifests itself in the form of muscle under- or over-activity which consequently affects motor behavior [1]. An undesirable directional preference is imposed due to involuntary muscle activity thereby inducing spasticity and consequently impeding ADL performance. Muscle under-activity is apparent as weakness, loss of finger dexterity and selective control of muscles. Muscle over-activity is characterized by exaggerated tonic stretch reflexes and tendon jerks. This research is an attempt to identify and study patterns of hand motor dysfunction in ADL performance as a result of brain injury (BI).

METHODS

The research is an on-going study that uses a video-based motion analysis system to record hand activity during grasping. The activity involves grasping a spherical object. Subjects were instructed to reach for and wrap their fingers around the object, without lifting the object, and then gradually release the object. The protocol was set based on [2,3] in order to assess the degree of voluntary finger extension. Data were collected and analyzed to observe patterns of hand coordination during grasping in patients after brain injury.

Prior to data collection, the 3D SIMI motion analysis system was calibrated for spatial alignment and orientation. Reflective markers (5 mm in diameter) were placed on the metacarpal (MCP) and interphalangeal (IP) joints of the fingers and thumb, the base of the 3rd metacarpal and the stylus of the ulna and radius (18 markers). Digital motion data was recorded at 60Hz for at least 8 secs. by three cameras. Spatial coordinate data were extracted from the motion clips of the grasping activity. These were used to calculate MCP and PIP joint angles. Passive range-of-motion for each finger joint and the wrist were also recorded. The abstract discusses a specific case and general observations.

RESULTS AND DISCUSSION

Figure 1 shows the MCP angle plot for the ring finger in the hand of a patient with bilateral hand motor dysfunction. The motion clips indicated that the patient initiated the dynamic phase of grasping by placing the fingers on the object, followed by lowering the wrist to stabilize the object in the palm. This is observed in the MCP angle plot wherein region-1 (R1) shows increased MCP extension followed by R2 with increased flexion due to lowering of the wrist for object stabilization. The same regions are identified in the other hand of the same patient which exhibits relatively better hand motor function.

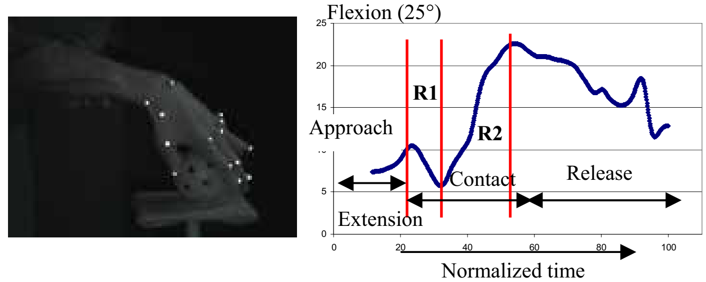

Figure 1: MCP angle plot of the patient's ring finger.

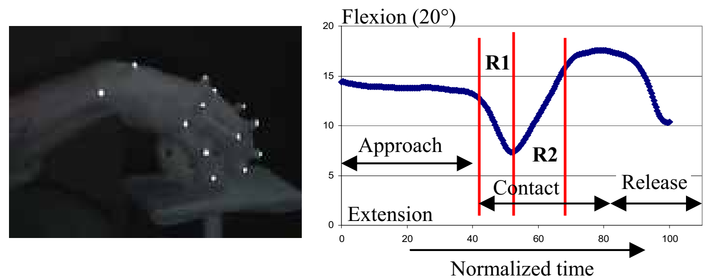

Figure 2: MCP angle plot of the ring finger in the other hand of the same patient.

The MCP and PIP angle plots were almost in phase in the controls, while the same was not the case in the brain injured patients. Table 1 lists the correlation values between the MCP and PIP angle plots of the fingers for the brain injured patients and age- and gender- matched controls.

CONCLUSIONS

In this pilot, it was observed that hand motor dysfunction after BI severely affects the release mechanism of the fingers. Patients tend to use different strategies for stabilizing the object in their hand. Relatively low correlation was observed between the MCP and PIP angles in the brain-injured patients. Further research is required to get a more generalized stratification of hand motor dysfunction in BI.

REFERENCES

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Table 1: Correlation between MCP and PIP joint angles.

Subject	Fore		Middle		Ring		Little		Thumb	
	L	R	L	R	L	R	L	R	L	R
Patient-1	0.52	-0.69	0.67	-0.55	0.71	0.47	-0.06	-0.63	0.89	0.49
Patient-2	-0.26	0.97	0.74	0.97	0.64	0.93	0.59	0.75	0.66	0.28
Control-1	0.93	0.74	0.78	0.83	0.83	0.65	0.24	0.77	-0.80	0.23
Control-2	0.97	0.56	-0.05	0.92	0.83	0.95	0.92	0.57	-0.75	-0.75