Novel mobile devices to quantify upper extremity motor function following epidural injections for cervical disc disease

Charles Li BS; Sunghoon Ivan Lee; Derek Lu; Peter Culmer; Mark Mon-Williams; Majid Sarrafzadeh PhD; Irene Wu; Daniel C. Lu MD PhD

UCLA Department of Neurosurgery; UCLA Department of Anesthesiology; UCLA Department of Computer Science

Introduction

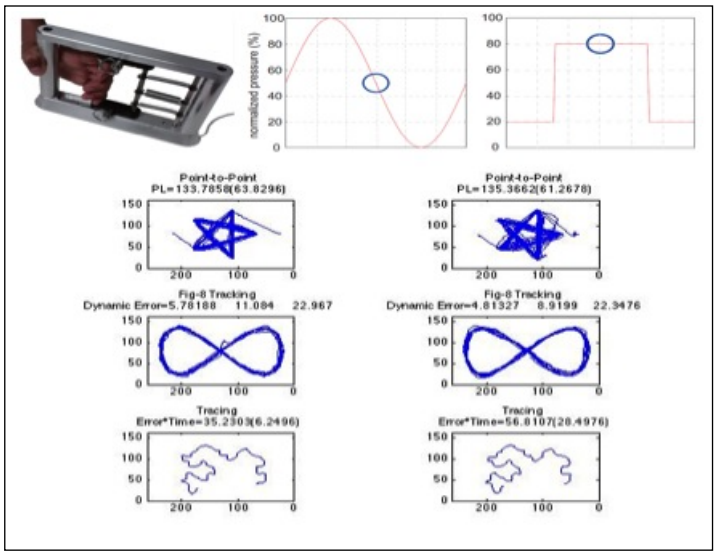
Methods used to assess function in patients with upper cervical pain have previously relied on subjective survey data, such as the Oswestry Disability Index (ODI) or Visual Analog Scale (VAS). This study introduces mobile devices (Kinilab and MediSens) to measure kinematic movements and handwriting abilities in patients undergoing cervical spinal cord injection and to correlate these findings to validated measures of pain and disability.

Learning Objectives

1. Mobile devices in the quantification of pain scores
2. Functional survey in the management of pain

Methods

Patients older than 50 were asked to perform a series of tracing tasks on two mobile devices. 10 patients were included in this initial study who were compared to an age matched control group of 10 subjects. The average age of the subjects was 48.9 and control was 53.4 (p-value = 0.35). The MediSens device evaluates patients using a sliding handgrip. Sinusoidal and step tracking tasks were used to assess gradual and sustained changes in grip strength, respectively. The mean absolute error (MAE) was used to quantify performance. Kinilab is a system that measures human hand movement using a series of configurable visual-spatial tasks. For the tablet device, movement data was analyzed using MATLAB® and independent values of movement time (MT) and shape accuracy (SA) were combined to form a speed accuracy cost function (SACF). This function was analyzed across the various tracing tasks to determine whether there was objective improvement in tracing accuracy following injection. Reliability was evaluated with test-retest analysis, internal consistency was assessed with Cronbach's alpha, receiver-operating characteristic (ROC) was used to determine responsiveness, and validity was evaluated by comparison to ODI and VAS scores.



Results

Patients showed a decrease in function on the tablet-tracing task of 6.25 AET (p-value=0.002) and a decrease in function on the sine function tracking task of 4.95 MAE (p-value=0.13). In comparison, there was no change in function within our healthy cohort in the tablet testing and an increase in function due to a learning curve effect in the handgrip test.

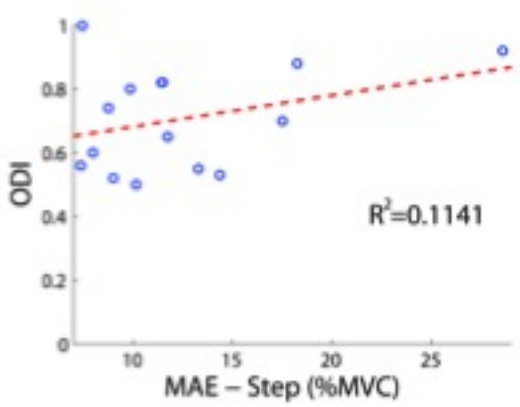
Changes in Motor Function vs MAE

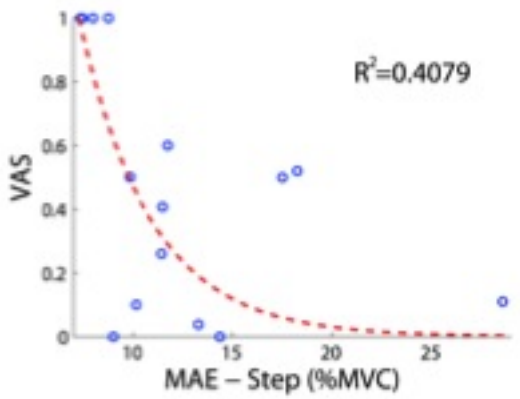
	Patients			Control		
	Average		P-Value	Average		P-Value
Kinilab	-6.52	↓	**0.00078**	0.97	—	0.99
Medisens	-4.94	—	0.13	0.79	↑	**0.024**

Changes in Pain Score

	Days FU	ODI Pre	ODI Post	VAS Pre	VAS Post
AVERAGE	21.3	0.342	0.31	60.5	48.26

ODI and VAS correlation to MAE





Conclusions

Mobile devices can be a powerful modality for detecting motor function changes in patients following cervical injections. These changes in function may not be adequately reflected using the current method of physician administered pain and functional surveys, which are strongly influenced by individual perception.

References

Culmer PR, Levesley MC, Mon-Williams, M, Williams JH. A new tool for assessing human movement: the Kinematic Assessment Tool, J Neurosci Methods, 2009 Oct 30; 184(1):184-92