The Effect of Lumbar Decompression on Patients’ Disability Measured by Spine Specific Wearables

Ram Haddas, Clarke Cady-Mccrea[1], Paul T Rubery, Ashley Rogerson, Varun Puvanesarajah[1]
[1]University of Rochester

INTRODUCTION:

Lumbar decompression for radiculopathy secondary to nerve root compression is a common procedure, leading to improvement in function in the appropriately selected patient. Continuous, remote objective measurement of patients function offers a novel approach for characterizing disability and surgical outcomes. We describe and validate a spine-specific wearable system to capture trunk kinematics, spatiotemporal parameters, and type of activity in the post-operative patient. Therefore, the purpose of this study was to assess the effect of lumbar decompression and fusion on patient's disability utilizing spine specific wearables.

METHODS:

A prospective, single-center, concurrent cohort study. Twenty-two Lumbar Degenerative surgical candidates underwent lumbar spine decompression with fusion. A week before (Pre) and 3 month following surgery (Post3), spine specific wearables were attached to patient's base of neck and passively recorded disability and functional outcomes for 3 days. At the end of each day, ODI and PROMIS were answered by patients. Outcome Measures included trunk Range of Motion (RoM), amount and type of physical activities, ODI, and PROMIS. Repeated-measurements ANOVA was used to compare outcomes before and after surgery using SPSS (IBM 2023).

RESULTS: Disability and function were improved following lumbar decompression and fusion as sited by spine-specific wearables and PROMIS. The volume of activities was significantly increased following surgery (% of the day; walking Pre: 16.0±9.1 vs Post3: 24±8.7, $p<0.05$;). Moreover, trunk RoM was increased (Sagittal: Pre: 30.4±11.3 vs Post3: 45.2±15.6◦ , $p<0.05$, Coronal: Pre: 30.0±12.9 vs Post3: 45.4±12.9◦ , $p<0.05$). Furthermore, PROMIS and ODI scores were significantly improved (PROMIS Physical Function: Pre: 71.1±9.7 vs Post3: 58.5±12.4, $p<0.05$; PROMIS Pain Interference: Pre: 69.4±11.4 vs Post3: 56.7±10.1, $p<0.05$; PROMIS Mood: Pre: 65.9±4.0 vs Post3: 60.1±7.7, $p<0.05$; ODI: Pre: 45.9±12.7 vs Post3: 32.3±11.7, $p<0.05$;). Although, DFOMs were improved in LD patients, they were still significant different form an age and gender matched controls ($p>0.05$). LD patients presented with lower free-living physical function along with reduced trunk kinematics (walking: 4.7±2.1%, standing: 11.6±3.6%, sitting: 25.3±12.8%, and laying down: 41.7±12.2% of the day, trunk flexion: 15.8±6.7°) at their home-based environment in comparison to controls (walking: 8.9±2.1%, standing: 19.1±4.9%, sitting: 17.1±9.7%, and laying down: 36.2±11.0% of the day, trunk flexion: 10.3±4.7°; $p<0.05$). Moreover, LD patients demonstrated reduced balance and gait with increased sway (balance effort: 25.6±11.7°, walking: 0.8±0.3 m/s, sway: sagittal: 7.9±2.8°, coronal: 7.2±3.0°) compared to controls (balance effort: 14.6±5.7°, walking: 1.0±4.4 m/s, sway: sagittal: 5.8±2.5°, coronal: 3.2±1.3°; Figure 2). Strong correlations were found between wearable DFOMs to the PROMIS scores ($r2 >0.55$, $p<0.05$).

DISCUSSION AND CONCLUSION: Lumbar decompression and fusion has been demonstrated to decrease disability and improve function in patients with radicular pain caused by nerve root compression. A novel spine-specific wearable system was able to quantify a patient's disability and functional level, with good correlation to improvements reported in PROMs. A combination of disability and function outcome measurements (DFOMs) to supplement PROMs and radiographic measurements provides a more comprehensive evaluation of a spine patient's health and assists physician in better treatment decision-making, a customized definition of return to work, and mitigate risk exposure. It may also be possible for healthcare providers to view their patients' DFOMs in real-time, allowing them to monitor their progress and refine their patient care accordingly.

Figure 1. Example of predict activity data of the spine-specific wearable sensor at home using artificial intelligence (AI). A. Balance/Cone of Economy Analysis; B. Gait Analysis, C. Lifting Analysis, D. Sitting Analysis, E. Sleeping Analysis

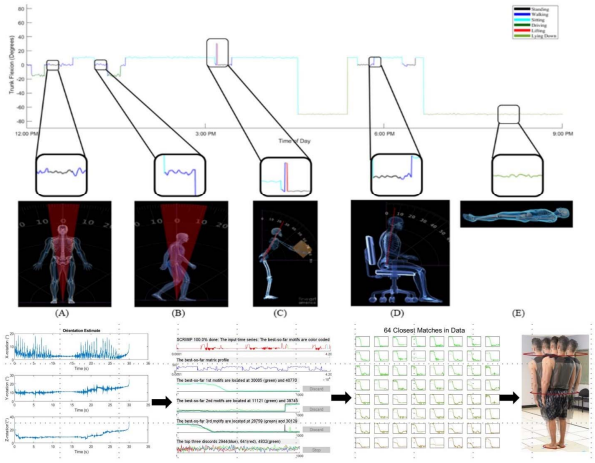

Figure 2. Cone of Economy Parameters using Spine-Specific Wearable of Degenerative Lumbar Patients 1 Month Before (Pre), and 3 Months after (Post) Surgical Treatment.