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Abstract

Introduction: The intensification of multimodal treatments for head and neck cancers (HNC) has created a cohort of patients living with both short- and long-term comorbidities and functional deficits. These sequelae need to be evaluated in both a subjective and an objective manner to better guide intervention design and supportive therapies. This study aimed to determine whether there is a relationship between subjective patient-reported outcomes (PROs) and objective measures of neck function in survivors of HNC.

Methods: Twenty-three subjects (age 63.2 ± 9.8; 20 male, 3 female) were recruited and completed the Neck Disability Index (NDI) and a numeric pain scale. Subjects were fitted with 2 wireless inertial measurement unit (IMU) sensors to collect range of motion (ROM) and velocity data. Differences between ROM and velocity were assessed using a two-tailed T test (*p<0.05). The Pearson correlation coefficient (r) was calculated between the NDI values and both the ROM and velocity values for each motion at each speed.

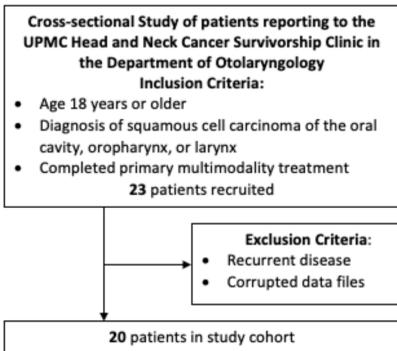
Results: The portable motion sensors were able to record reliable kinematic data in the clinical setting. No correlation was observed between NDI and Neck Pain. However, inverse correlations were found between both PROs and ROM and Velocity. Specifically, patients with no disability according to NDI, had significantly higher ROM and velocity than patients with mild/moderate disability and patients with 0 pain had significantly higher ROM and Velocity than patients with >0 pain.

Conclusions: This data has the potential to improve both treatment planning and delivery by facilitating a more nuanced understanding of both the daily experiences of HNC survivors and the pathophysiology that must be targeted in developing innovative and responsive adjuncts to address their psychosocial and functional deficits.

Introduction

- Standard of care treatment for head and neck cancer (HNC) incorporates multimodal treatment paradigms that result in acute and long-term toxicities.
- A significant proportion of survivors report impaired neck mobility and continued neck pain years after treatment completion.
- Surgical intervention leads to postsurgical scarring which may result in decreased muscle strength, especially related to the sternocleidomastoid and trapezius muscles that may be affected during neck dissections.
- Radiation therapy results in soft tissue fibrosis and lymphedema in many patients.
- The deficits associated with these toxicities impact survivors' everyday activities and often lead to a decreased quality of life, even after the completion of treatment.
- There is a need for an objective measure of neck function that can be used within the clinical setting.

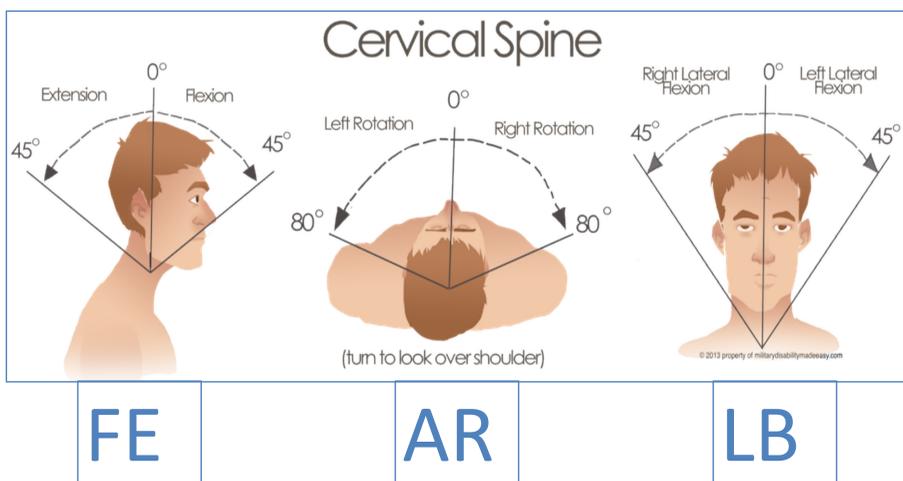
Methods and Materials



Patient Reported Outcomes Scores (N=20)	
Neck Disability Index Category (0-40)	n (%)
No Disability (0-4)	9 (45%)
Mild Disability (5-14)	9 (45%)
Moderate Disability (15-24)	2 (10%)
Pain Score Category (0-10)	
No Pain	7 (35%)
Faint Pain	4 (20%)
Mild Pain	6 (30%)
Moderate Pain	1 (5%)
Uncomfortable Pain	2 (10%)



IMU sensors. Subjects were fitted with 2 wireless inertial measurement unit (IMU) sensors (3-Space BT, Yost Labs) one on the back of the head and one on the upper back held by an elastic strap and harness. Range of motion (ROM) and velocity data were collected for axial rotation (AR), flexion and extension (FE), and lateral bending (LB) movements of the neck.

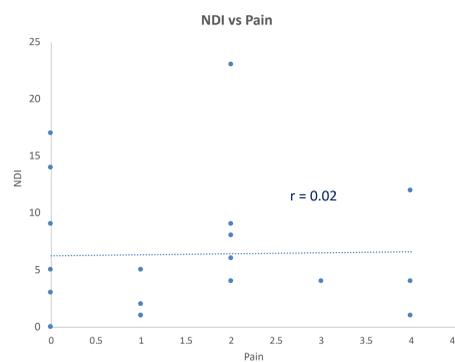
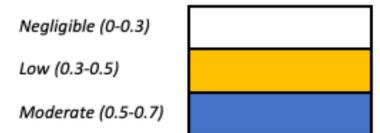


Objective Assessment. The participants were asked to complete 5 cycles of FE, AR, and LB at a self-selected comfortable velocity. Outcomes included ROM to assess motion restriction and velocity of cervical rotation to assess motor control.

Results

N = 20	No. (%)
Gender	
Male	17 (85%)
Female	3 (15%)
Age (mean ± stdev)	63.2 ± 9.8
Treatment Course	
Nonoperative	15 (75%)
Surgery & adjuvant treatment	5 (25%)
AJCC Stage	
I	2 (10%)
III	3 (15%)
IVa	13 (65%)
Not Collected	2 (10%)
Tumor Site	
Oral Cavity	2 (10%)
Oropharynx	12 (60%)
Larynx	3 (15%)
Hypopharynx	1 (5%)
Unknown Primary	2 (10%)
Treatment End Date	
Before Oct 2007	6 (30%)
Nov 2007-July 2013	4 (20%)
Aug 2013-Sep 2017	6 (30%)
Oct 2017-Jan 2019	4 (20%)

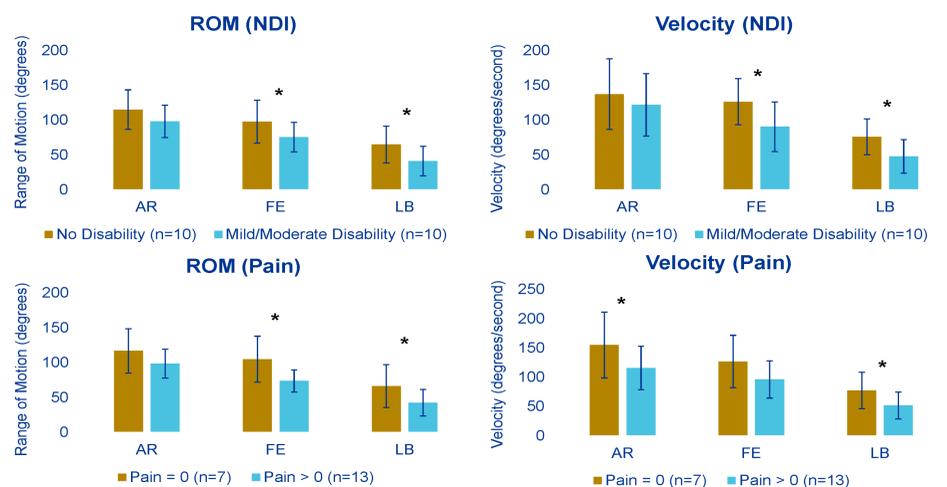
	Pearson Correlation (r)			
	ROM r Values		Velocity r Values	
	NDI	Pain	NDI	Pain
AR (fast)	-0.368	-0.275	0.025	-0.430
AR (slow)	-0.454	-0.153	-0.313	-0.215
FE (fast)	-0.461	-0.290	-0.133	-0.420
FE (slow)	-0.543	-0.383	-0.370	-0.322
LB (fast)	-0.459	-0.271	-0.211	-0.182
LB (slow)	-0.475	-0.292	-0.388	-0.407



Pearson Correlations for ROM and Velocity vs PROs

- Higher NDI correlated with lower ROM and Velocity.
- Higher neck pain correlated with lower the ROM and Velocity.
- The fast velocity was significantly greater than the slow velocity for all motions.
- No statistical difference was detected between slow and fast ROM values for the motions of FE and LB.

No correlation was observed between NDI and Neck Pain.



Patients who reported no disability on the NDI had more ROM and Velocity than the patients with mild/moderate disability. Difference was significant for FE and LB (p < 0.05). The patients in the pain = 0 group had significantly higher ROM in FE and LB and significantly faster velocity in AR and LB compared to the pain >0 group. “*” signifies p < 0.05.

Discussion

- This study aims to begin closing the knowledge gap in our ability to address deficits related to acute and long-term toxicities related to HNC by aligning patient-reported outcomes with physical performance measures in a targeted manner.
- The use of patient-reported outcomes is imperative in understanding the lived experience and daily limitations perceived by the patient.
- Both objective and subjective measures of treatment-related effects must be deployed in the clinical setting in order to develop meaningful and effective interventions.

Conclusions

- The portable motion sensors were able to reliably record neck movements within a clinical setting and detect significant difference between slow and fast velocity movements.
- The correlations found between both NDI and pain to ROM and velocity are negative, indicating that higher disability or pain correlates with reduced ROM or velocity.
- Those patients who reported no disability had significantly more ROM and velocity than those in the mild and moderate disability groups.

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