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A Comparative Analysis of Physical Examination measures in patients with non-specific neck pain as per International Classification of Functioning and Health impairment (ICF) based categorization of neck pain

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Abstract :
Neck pain is described as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage" in the neck region, which starts at the superior nuchal line and continues down to the level of the scapular spine.[1] There is a need to study the variations in range of motion, muscle strength of deep neck flexors, endurance of deep neck flexors and extensors and proprioception of cervical spine and prevalence of scapular dyskinesia among the four ICF based categories of neck pain patients. The patients were categorized into ICF impairment-based categories of neck pain by assessing cervical ROM and cervical-thoracic segmental mobility, cranial-cervical flexion test, deep neck flexor endurance test, Upper limb tension test and distraction test and Spurling's test. They were also assessed for scapular dyskinesia.Data analysis revealed that the Cervical ROM varied significantly across all the four(ICF impairment-based) groups of neck pain patients for most of the cervical movements except for flexion and right lateral flexion. The errors in proproception, disability also varied significantly across the four(ICF impairment-based) groups of neck pain patients for all the movements i.e flexion,extension,side flexion to both sides and rotations to both sides.All the ICF impairment-based categories of neck pain patients showed the presence of scapular dyskinesis except for the Cerviogenic headache(Category 3) group.
Key words: Cervical Spine, ICF, ICD, Disability, scapular dyskinesia

INTRODUCTION

Cervical pain has been defined by The International Association for the Study of Pain (IASP) as pain perceived anywhere in the posterior region of the cervical spine, from the superior nuchal line to the first thoracic spinous process.[1.] According to the Global Burden of Disease 2010 Study, neck pain is the fourth leading cause of years lost to disability, ranking just behind back pain, depression, and arthralgias[2.]Not only is neck pain a major cause for disability but also it has witnessed a progressively increasing prevalence.

Epidemiological studies across the world are showing substantial heterogenous prevalence of neck pain ranging from between 15% and 50% [3,4,5]. Owing to high prevalence and disability associated with neck pain various methods for assessment have evolved over a period of time to fine tune/calibrate /develop assessment protocols for subjects presenting with neck pain.

Towards this end neck pain has been categorized according to:

1. Mechanism
2. Duration (acute, <6 weeks; subacute, ≤3 months; chronic, >3 months)
3. Severity

Based on the mechanisms, neck pain can be classified as mechanical, neuropathic, or secondary to another cause (e.g., referred pain from the heart or vascular pathology).

There are two main diagnostic classification systems used internationally for chronic pain: The Diagnostic and Statistical Manual (DSM) published by the American Psychiatric Association (APA), and the International Classification of Diseases (ICD) published by the World Health Organization (WHO).[21] ICD is the foundation for the identification of health trends and statistics globally, and the international standard for reporting diseases and health conditions. It is the diagnostic classification standard for all clinical and research purposes.

The International Classification of Functioning, Disability and Health Impairment (ICF) classification complements WHO's International Classification of Diseases-10th Revision (ICD), which contains information on diagnosis and health condition, but not on functional status. The ICD and ICF constitute the core classifications in the WHO Family of International Classifications (WHO-FIC). The National Assessment and Accreditation Council (NACC) has responsibilities to WHO in its "Terms of Reference" to promote the development and use of ICF in the light of practical experience.

The ICF is structured around the following broad components:

- Body functions and structure
- Activities (related to tasks and actions by an individual) and participation (involvement in a life situation)
- Additional information on severity and environmental factors.

Considering the fact that people with one and the same clinical condition can vary substantially in terms of disability, this extension to the use of diagnoses has been identified. The Orthopaedic Section of the American Physical Therapy

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Association (APTA) has an ongoing effort to create evidence-based clinical practice guidelines (CPGs) for orthopaedic physical therapy evaluation and management of adult patients with musculoskeletal impairments described in the World Health Organization's International Classification of Functioning, Disability and Health (ICF).
Towards this endeavour. the 2008 neck pain clinical practice guidelines classified neck pain into 4 categories linked to the treatment-based model:
(1) Neck pain with mobility deficits,
(2) Neck pain with movement coordination impairments,
(3) Neck pain with headache
(4) Neck pain with radiating pain.
Litearture has pointed out towards restricted neck range of motion (ROM) in whiplash disorders, cervical spondylosis. which may interfere with their ability to carry out their ADL.Frequently medical interventions are often sought for neck pain relief but proprioceptive deficits are also associated with chronic neck condtions. Moreover, neck pain has a direct influence on an individual's ability to gain accurate proprioceptive information relative to position sense (PS) and alignment. According to various studies, in many cervical conditions such as whiplash associated disorders (WAD) or cervicogenic headache, a dysfunction of deep cervical flexors (DCF) such as longus colli and longus capitis can be found. Other studies also describe the deep cervical extensors as being dysfunctional: especially semi- spinalis, sub-occipital and multifidus muscles.
However none of them have actualy studied the variations in their dysfunction among The wide categories of neck pain. Routine Assessment of neck pain cases involve a whole plethora of clinical assessment measures inclusive of ROM, strength,endurance,propioception,scapular dysfunction and associated disability.
We propose that these assessment measures would be different across the four categories of neck pain identified by ICF. Hence this study aims at comparing the variations in Cervical ROM, Propioception , CCFT,DNFE ,DNEE and prevalance of scapular dyskinesis between the four categories of neck pain patient.

METHODOLOGY.
Study design: Prospective Exploratory Study Design
Study duration: 1 year
Study subjects: Neck Pain patients in the age group of 20-55 years with pain on VAS greater than or equal to 4
Sampling method: Random Stratified Sampling
Sample size: 120 calculated using the formula,

$$n \geq = \left(1+\sqrt{g-1}\right)\frac{\left(z_{1-\alpha/2}+z_{1-\beta}\right)^2}{d^2}+\frac{z_{1-\alpha/2}^2\sqrt{g-1}}{2(1+(g-1)}$$

where g = group, d= effect size,
g= 4
d=0.8
$z_{1-\alpha/2}$= 1.96
z_1-β = 0.7
α = type 1 error
β= type 2 error
Study setting: DY Patil Hospital & Research Centre
Materials Required: Patient information sheet and Consent form, Proforma, Cervical range of motion device, Pressure biofeedback device, 1.5kg and 2kg dumbbells, Copenhagen scale, Stop watch,Armrest chair with a pillow,Towel

OUTCOME MEASURES
Cervical Range of Motion: Flexion, extension, lateral flexion and rotation were assessed using Cervical Range of Motion (CROM) device.
Psychometric properties: it is a reliable and valid method:
The intra-examiner reliability for the CROM device ranged from moderate (ICC-0.70-0.69) to excellent. (ICC: 0.79-0.88). The inter-examiner reliability for the CROM device was excellent (ICC:0.76-0.93). CROM device has good criterion validity (r = 0.89–0.99).
Cervical Proprioception: Cervical Proprioception was assessed using Neutral Head Position (NHP) test with CROM. **NHP is accepted as a reliable test using a valid (CROM) instrument.**
Intra-rater reliability had ICC: 0.74–0.78 and standard error of measurement (SEM): 1.78–1.88. Inter-rater reliability for NHP had ICC: 0.74–0.79 and SEM: 1.79–1.87.
Strength of Deep Neck Flexors.CCFT test was used for measuring strength of deep neck flexors. I**t is a reliable and valid method with i**ntra- and Inter-examiner reliability of CCFT had ICC in the range 0.63 to 0.86. Construct validity of

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CCFT was satisfactory. (SE: 0.74, 95% CI: (0.22; 3.21). The instrument used is Stabilizer" Pressure Biofeedback Unit (PBU), Chattanooga, USA. The outcome measure used in this study is activation score and performance index.

Endurance of Deep Neck Flexors. DNFE TEST for measuring endurance of deep neck flexors which **is a reliable method.**Intra-rater reliability ranged from good to excellent (ICC: 0.82–0.91) for subjects without neck pain. Interrater-reliability ranged from moderate to good (ICC :0.67–0.78) for subjects without neck pain and was moderate (ICC 0.67) for subjects with neck pain.

Endurance of Deep Neck Extensors.DNEE test for measuring endurance of deep neck extensors.I**t is a reliable method with** inter-rater reliability was 'very good' (*k* = 0.800, SE of kappa = 0.109, 95% CI).

Scapular Dyskinesis. Scapular dyskinesis test was used for measuring scapular dyskinesia.

Ethical approval:

Permission for the study was obtained by receiving the approval from the Research Committee of Dy Patil Deemed to Be University, School of Physiotherapy. Participants completed an informed consent form in which they were explained about the study, were assured of confidentiality and explained about the voluntary and anonymous nature of participation.

STUDY PROCEDURE:

After obtaining a written informed consent from the subject, the subjects' demographic details were recorded. Each subject was, based on presenting complains and clinical presentation categorized into one of the four categories of neck pain given by ICF.

After categorizing the patients into one of the four groups of ICF, the subjects were assessed for cervical range of motion, proprioception of cervical spine, the strength of deep neck flexors and the endurance of deep neck flexors and extensors as per standard procedures as mentioned in methodology.

The subjects were also assessed for the presence of scapular dyskinesis (as per standard procedures as mentioned).

DATA ANALYSIS AND INTERPRETATION

A total of 120 subjects were recruited for the study from August 2019 to December 2019. (30 in each of the four ICF categories of neck pain). Tables were made using Microsoft Word and figures were plotted using Microsoft Office Excel. Associations denoted as statistically significant were those that yielded a p value of <0.05. The data was processed as follows:

Descriptive Statistics: for demographic data. (Age, BMI and Gender).

Analytical Statistics: for outcome measures (Cervical Range of Motion, Proprioception, DNFE, DNEE, Strength of Deep Neck Flexors and Prevalence of Scapular Dyskinesis).

DESCRIPTIVE STATISTICS: BASELINE PARAMETERS

Results of descriptive analysis at baseline are reported as Mean± Standard Deviation.

Table 1. Descriptive of Baseline Parameters.

Variables	**Mean ± Standard Deviation**			
	Category 1	**Category 2**	**Category 3**	**Category 4**
Number	30	30	30	30
Age	35.6± 11.11	39.10±10.06	35.53±9.68	43.07±6.02
BMI	24.72±3.72	25.44±4.53	25.15±4.45	22.56±4.11
Gender wise distribution (M: F)	1:2	5:1	1:9	1:2
VAS: Rest	5.03±1.38	6.07±1.26	5.27±1.11	5.47±0.90
VAS: Activity	6.30±1.26	7.27± 1.05	7.07± 1.08	7.30± 0.95

Analytical Statistics:

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Data was collected on standardized forms and encoded for computerized analysis using SPSS Software Version 22 for Windows. Tables were made using Microsoft Word and figures were plotted using Microsoft Office Excel. Associations denoted as statistically significant were those that yielded a p value of <0.05.

Inference:

The statistical test used was a **one-way Anova test**. The variations in CROM for extension varied significantly across the four ICF impairment-based groups which was more than that expected by chance (confirmed by the p value < 0.05)

As the variations were statically significant, a post hoc Dunn's Multiple Comparison test was used to compare between the group's variations.

Comparison of Cervical Range of Motion for Flexion in The Four Categories of Neck Pain Patients: The statistical test used was a one-way Anova test. The Cervical ROM for flexion **did not vary significantly** across the four ICF impairment-based groups since the p value was >0.05 which signified that the variations were not more than expected by chance. Therefore, the Cervical Rom for flexion does not vary significantly across the four ICF impairment-based groups.

Comparison of Cervical Range of Motion for Side Flexion in The Four Categories of Neck Pain Patients. The statistical test used was a one-way Anova test. The variations in CROM for side flexion varied significantly across the four ICF impairment-based groups which was more than that expected by chance. ($p<0.05$)

As the variations were statically significant, a post hoc test Dunn's Multiple Comparison test was used to compare between the group's variations.

Cervical left side flexion range of motion was in the order: Cat 3> Cat 4> Cat1 >Cat2

The statistical test used was a one-way Anova test. The variations in CROM for left rotation varied significantly across the four ICF impairment-based groups($p<0.05$) which was more than that expected by chance.

As the variations were statically significant, a post hoc test Tukey-Kramer's Multiple Comparison test was used to compare between the group's variations. Left rotation range of motion was in the following order: Cat 3>Cat1 >Cat 4>Cat2

There was a statistically significant difference with respect to Cervical Range of Motion: Left Rotation between Category3 and Category 4(Cat3>Cat4), Category 3 and Category 2(Cat3>Cat2), Category1 and Category 4 (Cat1>Cat4) as well as Category 1and Category 2 (Cat1>Cat2).

There was a statistically significant difference with respect to Cervical Range of Motion of Extension in following order: CAT3>CAT1>CAT4 >CAT 2.

Comparison of Errors in Proprioception: Extension in The Four Categories of Neck Pain Patients

The variations errors in proprioception: flexion & extension varied significantly across the four ICF impairment-based groups which was more than that expected by chance($p<0.05$).

As the variations were statically significant, a post hoc test Tukey-Kramer's Multiple Comparison test was used to compare between the group's variations. errors in proprioception: flexion was in the following order : Cat4>Cat3>Cat2>Cat1

The errors in proprioception: extension was in the following order: Cat3>Cat2>Cat4>Cat1

There was a statistically significant difference with respect to errors in proprioception: left rotation between Category1 and Category 3(Cat3>Cat1), Category1 and Category 4(Cat4>Cat1), Category1 and Category 2(Cat2>Cat1).

Comparison of Errors in Proprioception: Right Rotation in The Four Categories of Neck Pain Patients

Comparison of error in proprioception among For the Four Neck Pain Categories

As the variations were statically significant, a post hoc test Dunn's Multiple Comparison test was used to compare between the group's variations. Activation Score of deep neck flexors was in the following order:Cat1>Cat3>Cat4>CAT2

There was a statistically significant difference with respect to activation score of deep neck flexors between Category1 and Category 2(Cat1>Cat2), Category1 and Category 4(Cat1>Cat4), Category3 and Category 4(Cat3>Cat4), Category3 and Category 2(Cat3>Cat2).

The statistical test used was a one-way Anova test. The variations in Performance Index of deep neck flexors varied significantly across the four ICF impairment-based groups which was more than that expected by chance. ($p<0.05$)

As the variations were statically significant, a post hoc test Dunn's Multiple Comparison test was used to compare between the group's variations. Performance Index of deep neck flexors was in the following order:

Cat1>Cat3>Cat4>Cat2

DISCUSSION

The results of our study showed that cervical range of motion, proprioception of cervical spine, strength of deep neck flexors , endurance of deep neck flexors and extensors varied significantly across all the four groups.

In our study we found that amongst the four groups, least restrictions in cervical ROM was seen in neck pain patients with headache (Category 3) while neck pain patients with Movement coordination impairments(Category2) showed **maximum** restrictions in cervical ROM.

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Neck pain patients with movement co-ordination impairments (Category 2) showed **greatest restriction in active cervical Range of Motion**. This could possibly be attributed to the fact that trauma induces protective muscle spasm, leading to global decline in the active Cervical ROM.

Our findings corroborate the findings of Martin S. et.al in their study aimed at studying, "To What Degree Does Active Cervical Range of Motion Differ Between Patients with Neck Pain, Patients with Whiplash and Those Without Neck Pain?" This study had concluded that patients with Whiplash Assosciated Disorders(WADs) had less aCROM than patients with non-traumatic neck pain, stating traumatic origin has a negative influence on aCROM.

The results of our study demonstrated that the errors in proproception varied significantly across the four(ICF impairment based) groups of neck pain patients.Amongst the four groups of Neck Pain Patients as per ICF, Neck Pain Patients with Headache(Category3) showed greater errors in proprioception when compared to other ICF categories of neck pain patients.Also Neck pain patients with Mobility Deficits(Category1) demonstrated lower errors in propioception amongst the four ICF based groups of neck pain.

In our study we observed that errors in proprioception were present in all the four categories of neck pain patients. However neck pain patients with headache(Category3) had greater joint position error when compared to other three categories of neck pain patients.

Evidence in literature is suggestive of a greater tone in the suboccipital muscles in patients with cervicogenic headache as compared to healthy subjects. Jull G et al in their study have also showed greater stiffness and decreased extensiblity of the suboccipital muscles and upper trapezius in patients with cervicogenic headache than in healthy subjects. **Thus greater proprioceptive error in neck pain patients with headache could be attributed to affection of sub occipital muscles having abundant proprioceptors.**

The strength of deep neck flexors varied significantly across the four (ICF impairment based) groups. Activation score as well as performance index of deep neck flexors was greatest in the neck patients with mobility deficits(Category1) group and least in neck pain patients with movement coordination impairments (Category2) group.

In our study subjects included had chronic neck pain which was present for more than a year and such a long period could lead to muscle disuse. Also such a long period of pain could lead to fear for performing movement as a defence mechanism. A combination of the presence of pain, neck disability, kinesiophobia and possibly lower motivation levels explains the lower endurance time of deep neck flexors in neck pain patients with movement coordination impairments. Also reduced strength of deep neck flexors could be related to increased fatiguability.Thus lower endurance of deep neck flexors in neck pain with movement coordination impairments as compared to other groups of neck pain patients could be attributed to kinesiophobia, reduced strength of deep neck flexors and increased fatiguability.

All the ICF impairment based categories of neck pain patients showed the presence of scapular dyskinesis except for the Cerviogenic headache(Category 3) group.The subjects of our study had neck pain for a duration of more than a year with altered postural alignment. Forward head posture is a common malalignment found in neck pain patients. Scapular muscles share attachment with cervical spine and prolonged neck pain can affect the strength of scapular muscles.

CONCLUSION:

The Cervical ROM varied significantly across all the four(ICF impairment based) groups of neck pain patients for most of the cervical movements except for flexion and right lateral flexion.

The order of restriction of extension ROM was Cat2>Cat4>Cat1>Cat3.

The order of restriction for left lateral flexion restriction was Cat2>Cat1>Cat4>Cat3.

The order of restriction for left and right rotation was Cat2>Cat4>Cat1>Cat3.

The errors in proproception varied significantly across the four(ICF impairment based) groups of neck pain patients for all the movements i.e flexion,extension,side flexion to both sides and rotations to both sides.

The strength of deep neck flexors varied significantly across the four (ICF impairment based)groups.

The order of activation score and performance index across the four (ICF impairment based)groups was Cat1>Cat3>Cat4>CAT2.

The endurance time of deep neck flexors varied significantly across the four (ICF impairment based)groups.

The endurance time of deep neck flexors was in the order of Cat1>Cat3>Cat4>Cat2.

The endurance time of deep neck extensors varied significantly across the four (ICF impairment based)groups.

The endurance time of deep neck extensors was in the order of Cat1>Cat4>Cat3>Cat2.

CLINICAL IMPLICATION: Our study will open up new gates for exploration of all possible causes of variations in these physical examination measures.It will also provide an concrete assessment procedure for all neck pain patients. It will help in improvising the treatment approach towards neck pain patients with a better scientific evidence .

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