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Research Article

Neurophysiological Grading tool of Ulnar Nerve Entrapment Across Elbow: Revision and Corrections

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Abstract

Ulnar nerve entrapment across the elbow (UNEAE) is the second most common entrapment of the hand after carpal tunnel syndrome. There are few gradings available for UNEAE with their limitations.

The aim of this research is to establish, using the best available evidence, a clinically appropriate revision of the current ulnar nerve conduction grading tool and to evaluate its effectiveness in terms of acceptability, without any invasive tests. To make correction in the research papers which was highlighted in different conference recently. To compare the recording from the first dorsal interosseous (FDI) muscles with the abductor digiti minimi (ADM) muscle to see which muscle is more sensitive and shows early changes in ulnar nerve entrapment. To compare the significance of amplitude, drop and conduction block across elbow in terms of abnormality. The revised scale is designed from a clinical physiologist's perspective and based on the numerical values of nerve conduction findings. It could also assist surgeons to use this as a tool for interventional prediction.

The proposed revised grading system is based on more nuanced, descriptive categories, ranging from "normal, "early, "mild, "moderate, "severe," and "complete" absence. An additional category of clinical grading is therefore proposed.

Method:

Retrospect data was collected based on the extensive and detailed grading system previously described by Padua including hands skin temperature. The tests were performed by a qualified clinical physiologist (neurophysiology) using a Keypoint 9033A07 machine, used in line with departmental protocol (peripheral protocol 1, 2015). The Association of Neurophysiological Scientists (ANS) and British Society of Clinical Neurophysiology (BSCN) (2014) guidelines and minimum standards for the practice of clinical neurophysiology in the United Kingdom were followed including recording the temperature. All data was recorded numerically to ensure methodological reliability.

Result:

Retrospect data was collected over the course of one year (2017). A total of 190 patients were involved in this study. A collection of 278 consecutive symptomatic hands was tested for conduction block across the elbow while recording from the first dorsal interosseous FDI muscles. Out of the 278 samples, 201 hands were graded as having normal conduction velocity: 9 hands showed early changes, 51 hands showed mild changes, 14 hands showed moderate changes, 2 hands showed severe changes, and 1 hand showed complete absence or no response from the wrist and across the elbow.

Additional studies were carried out from the abductor digiti minimi (ADM) muscles for those patients who showed conduction block across the elbow while recording from the FDI muscles. Only 57 patients underwent a nerve conduction study for ADM. 77 symptomatic hands were tested for conduction block in the ADM muscle. 18 hands were graded as normal; 9 hands showed early changes; 48 hands showed mild changes; 10 hands showed moderate changes; and 1 hand showed complete absence or no response from the wrist and across the elbow.

Out of 278 hands, 266 hands were graded as having normal amplitude across the elbow while recording from FDI muscles; 7 hands showed early changes in amplitude; 1 hand showed moderate amplitude change; 4 hands showed severe amplitude changes.

Out of 77 abnormal hands, 73 hands showed normal amplitude across the elbow while recording from ADM muscles; 2 hands showed mild changes; 1 hand showed a moderate change; and 1 hand showed complete absence or no response from the wrist and across the elbow.

Conclusion:

Result shows that FDI is more sensitive in comparison to ADM to record early changes in ulnar nerve entrapment across the elbow. In addition, it shows that a drop in amplitude is not as significant when compared to a conduction block across the elbow.

Keywords : migraine ; pathophysiology ; prodromal / premonitory phase ; 'pre-prodromal' phase / 'pre-premonitory' phase ; migraine with aura (MwA); migraine without aura (MwoA) ; chronic migraine (CM)

Introduction

Ulnar nerve entrapment across the elbow (UNEAE) is the second most common entrapment of the hand after carpal tunnel syndrome[1]. There are only a few UNEAE gradings available, each with its own set of limitations. The cubital tunnel is the most common site for entrapment around elbow[5]. The most important signs of ulnar neuropathy at the elbow are the numbness in the 4th and 5th digits, hypoesthesia of the medial palm, atrophy and paraesthesia of ulnar nerve innervated hand muscles, and sometimes flexion deformity of the fingers due to motor dysfunction of the flexor carpi ulnaris muscle[4]. Motor nerve conduction studies (NCSs) are considered to be more sensitive when recorded from FDI than from ADM[5].

Reason for Grading of the Ulnar Nerve

The grading tool is used for the diagnostic assessment of the ulnar in conjunction with the patient's clinical history and symptoms[3] in order to diagnose the level of UNEAE[3]. The revised grading tool was made according to a physiological basis offers more precise numerical grading, that is both objective and repeatable. This would not only help the clinical physiologist to grade their results according to the proposed grading scale, but also support the surgeon to ascertain the level of severity in order to decide on either a conservative or surgical approach to treatment if they would like to adhere this grading.

Padua[7] grading in 2001 differentiated the level of entrapment of ulnar nerves across the elbow by recording from the ADM muscles with a small amount of data. He made five grades, i.e., normal, mild, moderate, severe, and very severe. Dellon[2] differentiated the level of entrapment of the ulnar nerve based on observations. Alessandro[8] in 2009 followed Padua[7] grading system and created a grading of ulnar nerve entrapment across the elbow while recording from the FDI and ADM muscles and also conducted an EMG study which is not recommended by ANS, BSCN guidelines for Clinical Physiologist at present. His sample size was also small too, and he suggested three gradings, i.e., mild, moderate, and severe. Another researcher investigated ulnar nerves through ultrasound or based on patients' symptoms, but only a few researchers suggested neurophysiological grading of ulnar nerves across the elbow. In 2015, Gulistan[5] published his paper with a small sample size, where he created 5 gradings of the ulnar nerve across the elbow, from normal to very severe, with extensive testing of the FDI and ADM muscles. Furthermore, the author included a needle EMG study in his grading. In the UK setting, where the majority of patients with ulnar nerve symptoms are investigated by physiologists who do not have EMG in their skill set and also not recommended by ANS and BSCN guide line till today.

It appears that whilst there is an accepted dominance of Padua[7] grading systems, there are also clear limitations, which are described in detail in this paper.

The aim of this research was to update the grading tool of Padua which was 16 years old and establish an evidence-based revision of the current ulnar nerve conduction grading tool and evaluate its effectiveness in terms of acceptability and usability as a tool for intervention prediction.

A numerical value is given to each of the grade bandings to enable objective reporting and comparision[5]. To compare the recordings from the first dorsal interosseous (FDI) muscles and the Abductor Digiti Minimi (ADM) muscle to evaluate which muscle is more sensitive and shows early changes in ulnar nerve entrapment. The revised scale is designed from a clinical physiologist perspective and based on the numerical values of nerve conduction findings. However, this could enable the surgeon to ascertain the level of severity in order to decide on either a conservative or surgical approach to treatment (if they wanted to follow the proposed grading). The proposed revised grading system is based on more nuanced, descriptive categories, ranging from normal to early to complete absence.

Method

Retrospect Neurophysiological data was collected based on an extensive and detailed grading system previously described by Padua[7]Including skin hand temperature which is followed by most of the clinical laboratories in the United Kingdom. In addition, few new grading was introduced in keeping with Padua[7] grading to justify the new grading scale according to advance technology. The data was compared between conduction block and drop of amplitude across elbow in FDI and ADM muscles to differentiate the grading system accordingly.

The Association of Neurophysiological Scientists (ANS) and British Society of Clinical Neurophysiology (BSCN) (2014) guidelines and minimum standards for the practice of clinical neurophysiology in the United Kingdom were followed including the temperature recording.

Patient and Public Involvement:

The test was performed by a qualified Clinical Physiologist (Neurophysiology) using the Keypoint 9033A07 (Skovlunde, Denmark) machine on the basis of departmental protocol (Peripheral protocol1, 2015). A quantitative method was used to collect the data[1], to ensure accuracy and avoid bias. The sample size of patients in the study was used for all those tested for NCS over a period of one calendar year (2017), across the population of North Wales. No individual patient was recruited in this research.

The inclusion criteria were considered only on the basis of the referral diagnosis. No clinical assessment was conducted in the department as no Neurophysiology Consultant is available during conducting the study. Patient medical history from referrals and from patient, related to the test was included in the report. The data was collected from patients with an age range above 18 years who were referred to the Neurophysiology department from the Orthopaedics and Neurology departments within the

local Health Board, as well as General practitioners (GPs) in North Wales. Referral of Ulnar nerve entrapment, Cubital Tunnel entrapment, Tennis elbow and Guyon's Canal entrapment was considered based on paraesthesia, pain, and swelling in the ulnar distribution area or digits IV-V and around the elbow.

Cervical radiculopathy, polyneuropathy, or any other clinical significance other than ulnar nerve entrapment was excluded from this research.

Data was analyzed on sensory amplitude, conduction velocity, motor distal latency, amplitude, and conduction velocity[5]. To introduce the terms "normal", "early", "mild", "moderate", "severe" and "complete", a numerical value was used that could be widely accepted and could be used to compare with other researchers.

The procedure began by carrying out the hand temperature above 30 degrees centigrade followed by sensory setting, by placing the stimulating ring electrodes on digit III, and recording the electrode on the surface of the median nerve on the wrist and for ulnar nerve testing, stimulating ring electrode placed on digit V and recording was made from medial part of the ulnar nerve distribution at wrist. The orthodromic technique was used for the sensory and motor Nerve Conduction Studies (NCS) test, through the median and ulnar nerves. A maximal current was applied to record the response of the nerve at the digits III for median sensory recording and digit V for ulnar sensory recording. Stimulating median nerve pathways at the wrist and at the elbow for motor recording from the abductor polices bravis (APB), and ulnar nerve pathways from First dorsal interosious (FDI). Measurement was made across elbows by keeping the elbows at 80-90 degree for ulnar nerve[1]. The distance across the elbow was kept constant between 10 and 12 cm[1]. Conduction velocity was recorded between writs to below elbow and across elbow. If the motor response from FDI displayed slow conduction velocity across the elbow, or more than a 20% drop in the amplitude with normal CV and amplitude between above the elbow and the axilla and between wrist to below elbow, then the response was recorded by stimulating the ADM muscles with the ulnar pathway from the wrist, below and across elbow and at the axilla[1]. If the response from FDI displayed low amplitude below the elbow, Martin Gruber's protocol was followed[1]. If the sensory amplitude in ulnar nerve digit V displayed low amplitude, a recording was made from the wrist by stimulating the ulnar nerve at the mid palm. If the response displayed low amplitude in mid palm, dorsal ulnar cutaneous nerve study was carried out by stimulating the dorsal side of the ulnar cutaneous branch to diagnosed Guyon's Canal entrapment. SNAP was recorded from peak-to-peak amplitude and conduction velocity from initial point to the peak. Sensory distal latency was not included in the data as it was not recommended by ANS and BSCN guidelines. Motor study recorded with distal latency, base-to-peak amplitude and conduction velocity between two responses. No muscles to wrist distance were recorded as hand size differ from patient to patient. If the sensory potentials have clear peak-to-peak waveform, no signal averaging were made. If the sensory amplitude is low and no clear baseline, signal averaging was done. Reference values for the electrodiagnostic procedure obtained from our normal data which is comparable with most of the publish research as well as publish books.

All patient data was collected by fulfilling the criteria mentioned in the above paragraph, depending on the severity. The reason for using the above criteria is to describe the full range of severity as well as to find the early changes, which was not fully covered by other researchers mentioned in this paper. The above criteria are intended to be more reliable in terms of grading for Clinical Physiologist and probably will provide support to the surgeon in terms of patient treatment decisions.

Retrospect data was collected for the wrist lesion in ulnar nerve pathways, and if there are signs of Martin Gruber anastomosis, which were not included in this research.

The following grades were stablished by considering the normal data collection in the department on the basis of ANS/BSCN guidelines and slight changes made according to department data collections which are as follows:

Absolute Conduction Velocity across elbow or drop of amplitude across elbow.

Normal: Sensory and motor CV≥50 m/s in FDI and ADM from across elbow and from digit V to wrist, Mid-palm to wrist and dorsal ulnar cutaneous nerve distal, Distal motor latency ≤4.2 ms, and motor amplitude at wrist and across elbow ≥5mv and sensory amplitude between digit V to wrist, Palm to wrist and dorsal ulnar cutaneous nerve are ≥5µv,

Early: CV=41-49m/s in FDI across elbow and normal between above elbow to axilla and Normal CV in ADM across elbow with normal sensory potentials between digit V to wrist. Or more than 20% drop of amplitude in FDI across elbow and normal amplitude in ADM across elbow with normal sensory potential between digit V to wrist.

Mild: CV=41-49m/s across elbow in both FDI and ADM and normal between above elbow to axilla with normal sensory potentials between digit V to wrist. Or more than 20% drop of motor amplitude in FDI and ADM across elbow, normal between above elbow to axilla with normal sensory potential between digit V to wrist

Moderate: CV=30-39m/s in both FDI and ADM across elbow with low sensory potentials from digit V to wrist and normal between palm to wrist. Or motor amplitude drops more than 40% across elbow in both FDI and ADM and normal between above elbow to axilla.

Severe: CV <30m/s in FDI and ADM across elbow and normal between above elbow to axilla with absent sensory nerve action potentials between digit V to wrist, palm to wrist. Dorsal ulnar cutaneous nerve either has low amplitude and slow conduction velocity or absent potentials.

Complete: Sensory and motor responses from FDI and ADM, digit V-wrist, palm to wrist and dorsal ulnar cutaneous nerve are absent. Need further study to localize the lesion above axilla or neck.

Result:

The data was collected for a period of one year (2017). A total of 190 patients were involved in this study.

Conduction block

278 consecutive symptomatic hands tested for conduction block across the elbow while recording from FDI muscles. 201 hands were graded as having normal conduction velocity; 9 hands showed early changes; 51 hands showed mild changes, 14 hands showed moderate changes; 2 hands showed severe changes and 1 hand showed complete absence or no response from wrist and across elbow.

Additional studies were carried out to ADM muscles for those patients who showed conduction block or drop of amplitude across elbow while recording from FDI muscles. Out of 278 hands, only 77 symptomatic hands were tested for conduction block for ADM muscle. Out of 77 hands, 18 hands were graded as normal; 48 hands showed mild changes, 10 hands showed moderate changes and 1 hand showed complete absence or no response from wrist and across elbow.

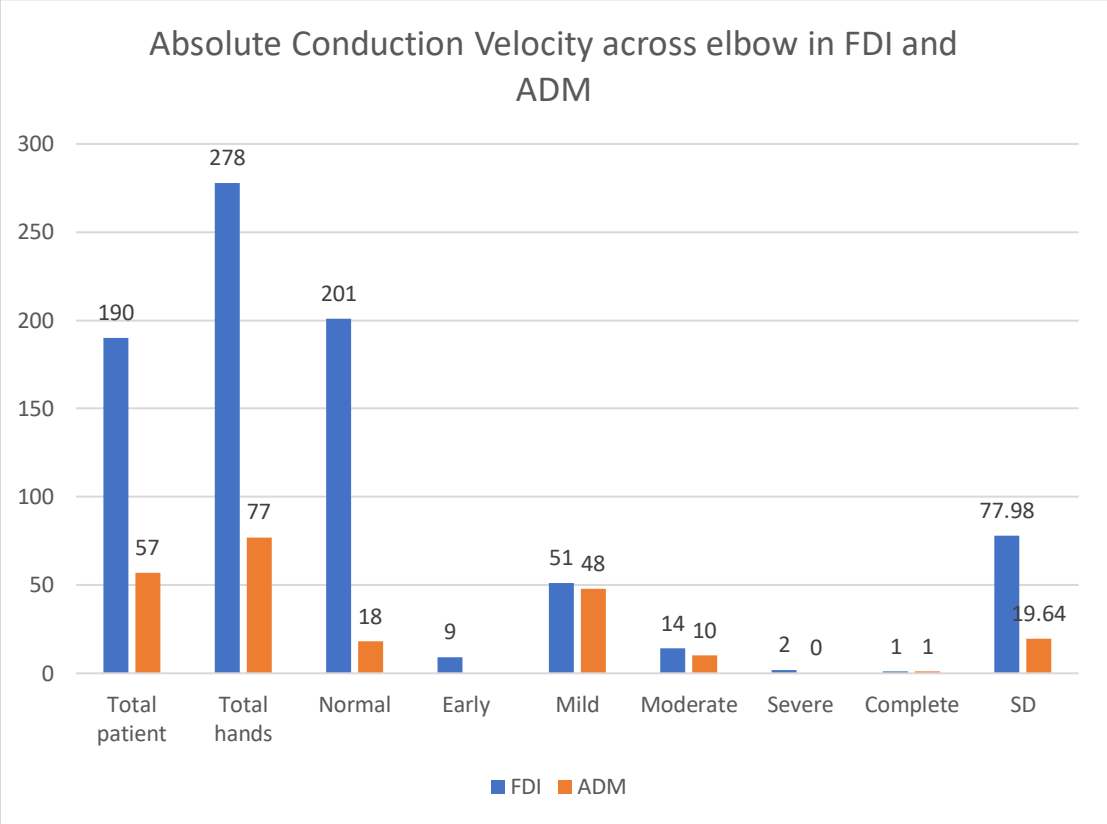
Drop of amplitude:

Out of 278 hands, 266 symptomatic hands were graded as normal amplitude across elbow while recording from FDI muscles; 7 hands showed early changes in amplitude; 1 hand showed moderate amplitude changes; 4 hands showed severe amplitude changes and 1 hand showed complete absence or no response from wrist and across elbow.

Out of 77 hands, 73 symptomatic hands showed normal amplitude across elbow while recoding from ADM muscles; 2 hands showed mild changes, 1 hand showed moderate change and 1 hand showed complete absence or no response from wrist and across elbow.

Comparing the gender and hands testing, females are more likely to be affected compared to males, and the left hand is more likely to be affected as compared to the right.

While comparing between conduction block and drop amplitude across elbow, our data shows that drop of amplitude across elbow which was not as prevalent when compared to the conduction block, while recording from both FDI and ADM muscles. In addition, we also noticed that FDI shows early conduction block across the elbow as compared to the ADM.



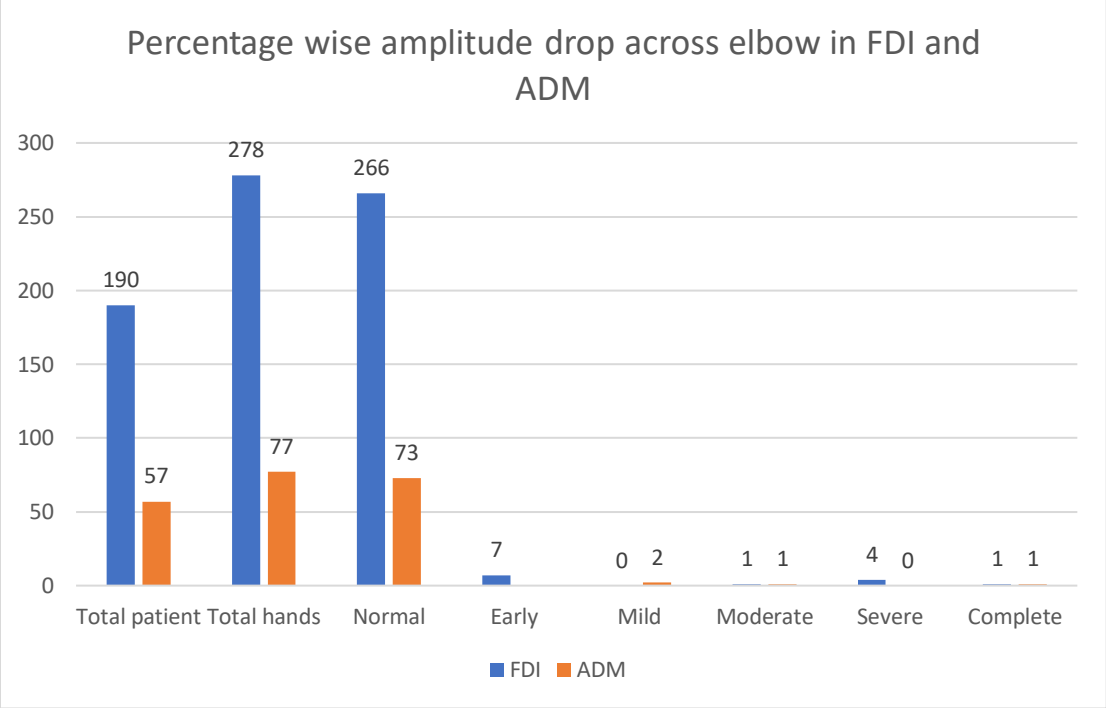
Graph 1: Absolute conduction velocity difference across elbow in FDI and ADM

	FDI	ADM
Total patient	190	57
Total hands	278	77
Normal	201	18
Early	9	0
Mild	51	48
Moderate	14	10
Severe	2	0
Complete	1	1
SD	77.98	19.64

Table 1: Absolute Conduction Velocity across elbow in FDI and ADM

	FDI	ADM
Total patient	190	57
Total hands	278	77
Normal	266	73
Early	7	0
Mild	0	2
Moderate	1	1
Severe	4	0
Complete	1	1
SD	107.6	32.2

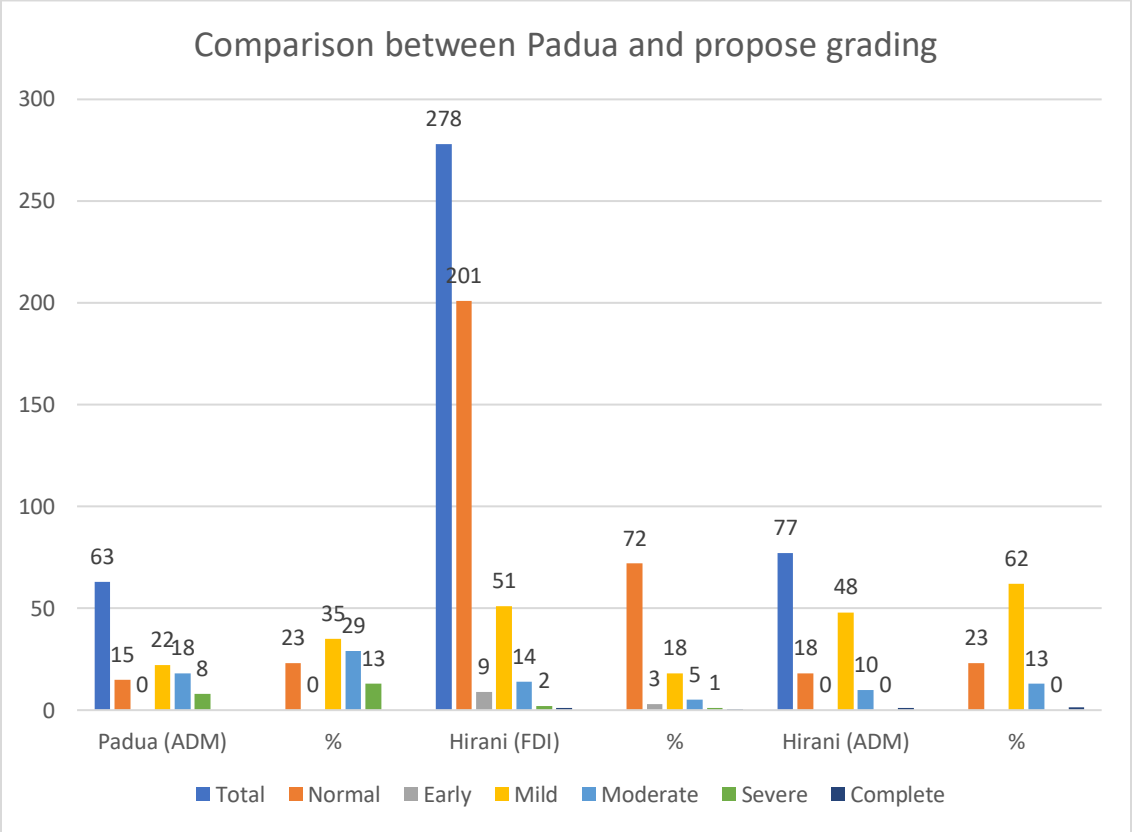
Table 2: Percentage wise amplitude drop across elbow in FDI and ADM



Graph 2: Persantage wise amplitude drop across elbow in FDI and ADM

Comparison between Padua and propose grading. (Please note that In Hirani grading, ADM are all those who already have shown abnormal in FDI)						
	Padua[7] (ADM)	%	Hirani (FDI)	%	Hirani (ADM)	%
Normal	15	23	201	72	18	23
Early	Padua didn't categorize grading in early stage		9	3	ADM show normal CV in early stage	
Mild	22	35	51	18	48	62
Moderate	18	29	14	5	10	13
Severe	8	13	2	1	0	0
Complete			1	0.4	1	1.3
Total	63		278		77	

Table 3: Comparison between Padua and propose grading

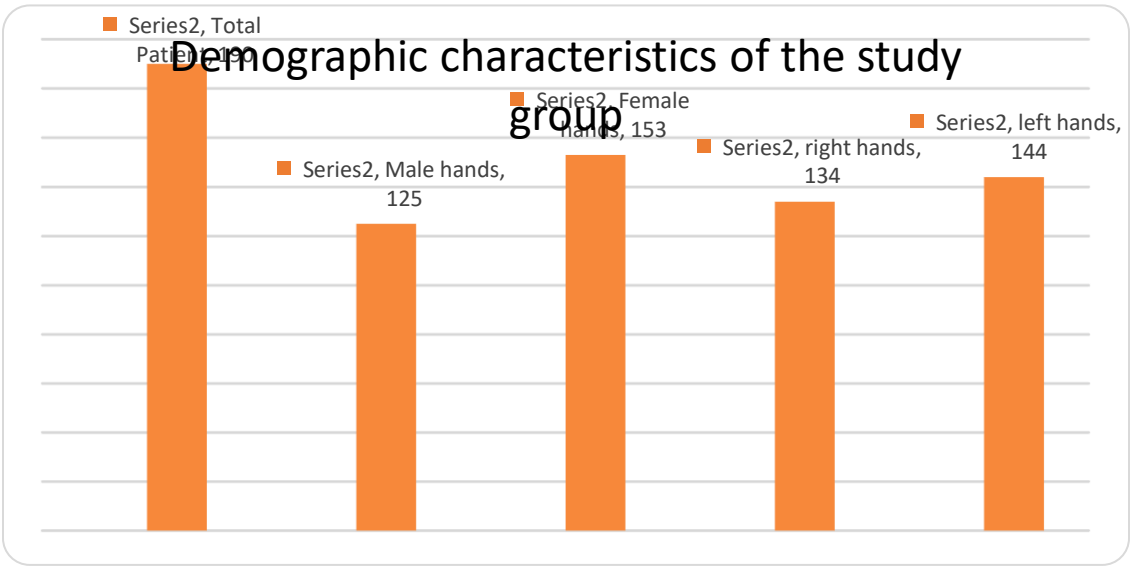


Graph 3: Comparison between Padua and propose grading.

(Please note that In Hirani grading, ADM are all those who already have shown abnormal in FDI)

Total Patient	190
Male hands	125
Female hands	153
right hands	134
left hands	144

Table 4: Demographic characteristics of the study group



Graph 4: Demographic Characterstics of the study group

Discussion:

Gulistan grading for NCS is very similar to the proposed grading. The only difference is that, we included an early entrapment of ulnar nerve from FDI on the basis of conduction block, or a drop of amplitude across the elbow and he included EMG study which is not recommended by ANS and BSCN guide lines

Comparing the ADM grading between Padua[7] and the proposed grading, they show similar values in ADM. We cannot compare the proposal grading with Padua[7] in FDI because Padua[7] did not collect the data through the FDI muscles. FDI shows an early sign of ulnar nerve entrapment, which is mentioned in the proposed grading.

Padua[7] grading for ADM is the most commonly used grading system by most of the researchers. However, due to small amount of data, the Padua[7] grading does not enable the level of severity to be objectively and fully ascertained. Gulistan[5] grading is similar to proposed grading because he included FDI and ADM both in his research. Gulistan did not make any clarification in his research paper, as his grading shows no differences between FDI and ADM. In the revised grading, the early stage of involvement is graded as Grade 2, which differentiates between the involvements of the muscles.

Conclusion:

The grading system devised by Padua[7] which was used to grade the levels of severity of ulnar nerve within the UK, has certain limitations, similar to the grading by Gulistan[5]. The grading system needs modification in order to accommodate current practices as present grading system is more than 17 years old. The revised grading system for ulnar nerves is based on a review of a broad spectrum of current and past literature. Within the limits of this study, the present investigation demonstrates that the revised grading tool will be better than Padua[7] grading in ADM in percentage wise but has bigger data as compare to Padua[7]. By adding FDI to the Hirani grading, it will enable the detection of an Early stage of the ulnar nerve entrapment across the elbow.
The revised grading tool using a physiological basis offers a precise numerical grading that is both objective and repeatable. This could not only help the Clinical Physiologist and Consultant to grade their results according to the proposal grading scale, but also support the surgeon in ascertaining the level of severity and helping to decide on either a conservative or surgical approach to treatment. Please note that this research was made to amend the grading for Clinical Physiologist. Although, surgeons have to make their own decisions for the treatment of UNEAE. It would be advisable to begin physiotherapy treatment in the early grades. Conservative treatment or intervention of steroid treatment is appropriate for the mild grade; a surgical approach would be useful for the moderate grade, where the chances of full recovery are higher. A surgeon could decide to go for a surgical intervention for Severe Grade, regardless if it would be beneficial or not, given the patient age and other medical history. Further EMG needles examination would be helpful to diagnose the level of severity in complete block or complex condition of ulnar nerve.

Written Consent from participants:

A written consent was obtained from all participants and filed in patient notes and a copy kept in the department. No ethical permission was obtained as this research was published in open access.

Consent for Publication:

Not Applicable

Availability of data and materials:

The datasets analyzed during the current study are not publicly available as they are held within patient records but are available from the corresponding author on request.

Competing Interests:

The authors declare that they have no competing interests.

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No one funded this study for publication.

Author's Contribution:

The Author contributed by the collection, analysis and interpretation of data and in writing the manuscript.

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References

1. AAEM Practice parameter for electrodiagnostic studies in ulnar neuropathy at the elbow: summary statement. Muscle Nerve, 22, 408-41,11999
2. Dellon L Review of treatment results for ulnar nerve entrapment at the elbow: The Journal of Hand surgery. 14(4):1989,
3. Edward E et al. (2013). Ulnar nerve at the elbow – normative nerve conduction study. Journal of Brachial Plexus and Peripheral Nerve Injury, 8:2.
4. Gu Y: (2011). Current status and suggestion of clinical classification of carpal and cubital tunnel syndromes. Zhongguo Gu Yu Guan Jie Sun Shang Za Zhi, 3:818-819.
5. Gulistan H. (2015). Ulnar nerve entrapment neuropathy at the elbow: relationship between the electrophysiological findings and neuropathic pain. *J. Phys. Ther. Sci, 2214:27:7.*
6. Karatas A, Apaydin N, Uz A, Tubbs R, Loukas M and Gezen F: (2009). Regional anatomic structures of the elbow that may potentially compress the ulnar nerve. J Shoulder Elbow Surg,.18:627-631.
7. Padua L. (2001). Neurophysiological classification of ulnar entrapment across the elbow. Neurol Sci Vol. 22: 11-16.
8. Volpe A, Rossato G, Bottanelli M, Marchetta A, Caramaschi P, Bambara LM, et al. (2009). Ultrasound evaluation of ulnar neuropathy at the elbow: correlation with electrophysiological studies. Rheumatology (Oxford), 48:1098-1101.
9. Salim Hirani. Neurophysiological grading tool of ulnar nerve entrapment across the elbow. J Neurol Neurol Sci Disord 9(1): 009-0013.

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