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Research Article

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Diagnosing Carpal Tunnel Syndrome in the Clinic: A Questionnaire and Physical Assessment Versus a Portable Nerve Conduction Test Device

Marnin Joseph Romm[1]* and Tejashree M Joshi[2]

[1]*PhD, MSc Pain, MSc Physiotherapy, BA (Hons) Clinical Psychology*

[2]*MSc Sports and Exercise Medicine, B. Physiotherapy, Oxford University Hospital NHS Foundation Trust*

***Corresponding Author**
Marnin Joseph Romm, PhD, MSc Pain, MSc Physiotherapy, BA (Hons) Clinical Psychology

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Abstract

Objective

The aim of this study was to evaluate the relationship between a clinical assessment questionnaire for Carpal Tunnel Syndrome (CTS) and a portable nerve conduction test device (Mediracer) in the diagnosis and severity of CTS symptoms.

Method

The research utilized a cross-sectional design including 100 subjects with CTS. A devised questionnaire assessing CTS symptomology and the Mediracer were administered to participants. Data regarding the severity of symptoms was analyzed using linear regression to compare the questionnaire with the device.

Results

A statistically significant correlation ($p<0.05$) was found between the diagnosis of CTS using the questionnaire and the Mediracer results. However, when divided into various subgroups, limited statistically significant correlations were found.

Conclusions

With a moderately large sample size of individuals with CTS, there appears to be a significant correlation between a clinical assessment using a questionnaire and the use of a portable nerve conduction device (Mediracer). To gain high CTS diagnostic accuracy, the current study showed it useful for health care professionals to utilise both of the above assessment tools

Keywords: Carpal Tunnel Syndrome, Median Nerve, Diagnosis, Nerve Conduction Test, Diagnosis.

1. Introduction

Carpal Tunnel Syndrome (CTS), is the most frequent peripheral nerve compressive neuropathic syndrome of the upper extremity worldwide [1-5]. CTS affects approximately 1 in 25 adults [1,6,7]. Stress and pressure on the median nerve within the carpal tunnel is the predominant feature of CTS [1,8,9]. Although there are numerous well-known risk factors for CTS, the core cause for the pathology remains not fully understood [1,10]. CTS produces symptoms of pain, numbness and tingling in the upper limb and hands and is an essential catalyst for work and other social disability. In limited cases, long-standing compression of the median nerve can cause permanent loss of sensory and motor function of the specific hand [3,11]. The clinical signs and symptoms based on physical examination results in patients with CTS are recognized broadly [3,12]. The manner in which to treat a patient with CTS was initially based on clinical findings [13]. Although there appears to be some level of universal agreement on clinical examination findings that suggest a diagnosis of CTS, there still does seem to be debate around the evidence underlying the most optimal approaches for assessment of CTS and to navigate

treatment decisions [3]. In the majority of cases, a cautious history taking, and physical assessment appear to be adequate to produce a presumptive diagnosis of CTS [14,15]. However, research suggests that even the most experienced clinicians can incorrectly diagnose a person with CTS, or may be staggered when unsuspected CTS is revealed [14]. The diagnosis of CTS based purely on an individual's signs and symptoms is suggested to be less reliable than other common upper limb pathologies such as tendonitis and cervical radiculopathy, which all may result in similar signs and symptoms to that of CTS [16,17]. Thus, further objective methods for evaluation including electrodiagnostic tools and nerve imaging, are said to supply extra information regarding the degree of axonal involvement and physical alteration, however their precise benefits to patients remains unclear [3,18,19]. As a result, CTS is one of the most common upper extremity pathologies for which nerve conduction tests are used [20,21]. There are mixed reports around the correlation between clinical signs and symptoms of CTS and electrophysiological findings. Numerous researchers have revealed a weak relationship between clinical features and electrophysiological findings [13,19,22-26]. Basheer et al (2019) found no statistically significant relationship between neurophysiological assessment (NCS) findings and CTS-related functional limitations and symptom severity [19,22,23,27,28]. On the hand, other research has found a significant correlation between clinical signs and symptoms of CTS and NCS findings on examination [24,26,27,29-31]. Ultimately, the outlook upon electrodiagnostic (EDX) tests used to assess the occurrence of CTS may be there to confirm the clinical diagnosis of CTS, its severity and rule in/out potential coexisting conditions [32-34].

The amalgamation between a clinical examination and a medical history taking by an experienced hand surgeon proved to be most sensitive, whereas the neurophysiological assessment (NCS) revealed the greatest specificity [3,11,19,26,33]. The neurophysiological assessment incorporated nerve conduction velocity (NCV) assessment in the median and ulnar nerves. A clinical assessment by an experienced physician appears sufficient if typical symptoms of CTS are present and pain is not conspicuous. If there is a history of intense pain, atypical symptoms or past fractures in the arm, wrist or hand, it is viewed as important to add a neurophysiological examination [3,34]. You, Simmons, Freivalds et al (1999) found significant relationships between clinical symptomatic scales (numbness, tingling, nocturnal symptoms, pain, weakness and clumsiness) and nerve conduction measures [35,36]. In contrast to the above, Levine, Simmons, Koris et al (1993) found an insignificant relationship between the overall symptom severity scale in CTS and conduction velocity of the sensory portion of the median nerve [22,33]. Hence, the severity of CTS symptoms cannot be approximated by nerve conduction measurements. Therefore, diagnosis should generally be made on the foundation of the individual's history and clinical assessment, with the added assistance of electrophysiological tests to confirm the clinical diagnosis if need be [37,35,34]. Relying, relying exclusively on the clinical assessment in making the diagnosis of CTS may result in not only missing the diagnosis of CTS in some people but also lead to inaccurate diagnosis and unnecessary surgery in others [38,39].

Nerve conduction tests are recommended to be considered as an indispensable feature in the pre-operative examination [2]. On the other hand, relying solely on nerve conduction tests may result in some patients who actually have a true diagnosis of CTS being denied surgical treatment, based on the possibility of normal test results [2,38,39] .Although improvements in the motor and sensory conduction (NCS's) after surgery are found, they did not correlate with the alterations in symptom severity and functional status scales measured by the Boston self-administered questionnaire [13,40]. Mondelli, Reale, Sicurelli et al (2000) also found no correlation between the Boston self-administered questionnaire and electrophysiological investigations when administered post CTS surgery [24,41].

Despite obvious inconsistencies, nerve conduction studies (NCS) undoubtedly have benefits [33,34,42]. NCS are able to demonstrate objective confirmation of nerve dysfunction, and in turn may help in the selection of individuals for a specific treatment, particularly if there is a sound correlation between pretreatment results of NCS and clinical outcomes [41,42,43]. Numerous tools have been used to examine the outcomes of CTS treatment [1,44]. These incorporate nerve conduction tests, symptom surveys, sensibility testing pinch or grip strength measurements, complication rates, examination of pain levels and dexterity, return to work and functional capacity [1,44]. In addition, certain self-administered questionnaires have been developed for the assessment of CTS pre-treatment and post treatment [22,45]. Since the relief of symptoms and enhancement of functional status are the core determinants of a treatment's accomplishment, necessity of NCS strongly draw a parallel with clinical outcome measures and is therefore important in the clinical setting [42]. Formal NCS are expensive and time consuming [15,42]. The introduction of portable nerve conduction instruments has come about to bring simple and inexpensive means to measurements [46,47]. The sensitivity and specificity of these devices has been studied in various meta-analyses for median neuropathy (MN) diagnosis. The results of some of these studies these devices to have a sensitivity from approximately 88% and a specificity of about 93% [46,47,48]. The studies have revealed that distal motor latencies recorded with the electroneurometer are slightly higher than those gained recorded with formal electrodiagnostic testing and continue to add that based on previous investigations, conventional electrodiagnostic testing appears to offer no significant benefit over electroneurometer in the diagnosis of CTS [46]. Through administering electrodiagnostic studies with the portable electroneurometer "the clinical diagnosis of carpal tunnel syndrome can be confirmed, the severity of median nerve compression can be assessed, and in patients with normal measurements, potential proximal compression sites can be sought" [46,48]. The newer nerve conduction techniques appear to have greater sensitivity for the diagnosis of CTS [21,48], however

there are still false positive and false negative results produced [21,49]. Importantly "patients with a normal sensitive NCS have very mild CTS if they have it at all and if the clinical features are not typical, the benefits of surgery should be carefully considered" [21,50,51].

In terms of the significance of the current research, individuals based in the UK with upper limb nerve compressions, trauma or CTS are referred either straight to hand therapy, such as a physiotherapist or occupational therapist, for example, or to a specialist hand consultant. If EMG or NCS's are needed, they presently have to be asked for by a doctor. This process is both lengthy (patients generally have to wait approximately 3 months for the testing to be done) and also costly in terms of delay of treatment with possible progression of symptoms within this time-frame. Access to a nerve testing device such as the Mediracer, would allow a full service to be offered without the need for further appointments with the consultant and the Neurophysiology departments. In turn, hand therapists would consequently manage a significant amount of patients through to discharge thus minimising the need for further medical consultations. The Mediracer was developed by clinical Neurophysiologists. Through thorough clinical trials, the Mediracer has been established to have a sensitivity of 94% and specificity of 98% when compared to a conventional EMG test when performed by a specialist neurophysiologist. The distinctive nature of this device is that it permits non-physicians to administer a valid test in a reliable method. Ultimately, the testing device should hopefully allow therapists to validate their clinical diagnosis and assess their treatment effectiveness.

2. Methods

The research and data collection was conducted by a therapist team at Guy's and St Thomas' NHS Foundation Trust in London, United Kingdom. The team administered the CTS questionnaire and the Mediracer NCS to the study's sample. In turn, the relevant data for the research was collected. The authors of this research reported how the study was conducted, the results of the study and a discussion around the overall research. The research utilized a cross-sectional design. There were 100 consecutive patients referred to the research team for CTS. The inclusion criterion for the subjects in the study was a diagnosis of CTS. The exclusion criteria included a previous upper limb nerve injury, previous cervical radiculopathy (although some of these subjects did happen to 'slip' into the main sample) and patients who had diabetes (although once again, some of these subjects also 'slipped' through). The patients were then assessed and given the questionnaire for CTS. Thereafter, on two separate visits, each subject was first assessed with the Mediracer and on the second visit, a neurophysiology examination took place. An average of three Mediracer readings was taken bilaterally. In patients who had bilateral symptoms of CTS, the worse side according to the subject's report was tested second (after the less severe side). Importantly, subjects were instructed to avoid nicotine and/or alcohol use for 3 hours prior to the Mediracer examination. The Mediracer test is performed using disposable surface electrodes placed on the wrist and fingers. The instrument measures the nerve conduction within the hand and correlates them to the normal values that have been found. The test requires no preceding knowledge of neurophysiology. Once all the data was collected, the mean was investigated along with its range of scores for both the questionnaire and Mediracer results.

The relationship/correlation between the questionnaire and Mediracer results were then explored through the use of a linear regression. The linear regression allowed for a relationship between the 2 sets of scores to be studied. Within the linear regression, the questionnaire was placed as the independent variable and the Mediracer as the dependent variable. Analysis of the whole data was followed by analysis of different groups derived from the whole data including: left side symptomatic group, right side symptomatic group, bilateral symptomatic group, ambiguous symptomatic group (described later), male group and female group. Means and ranges were explored for these subgroups. In addition, the individual correlations between the questionnaire scores and Mediracer scores for these subgroups were analysed using linear regressions. For all the above, standard deviations and power for each group was examined. Once all the above information was collected, analysis of the results was carried out.

3. Results

100 subjects participated in the study of which 21 were male and 79 females (21% male and 79% female). The mean age was 48.8 years old. The oldest subject was 85 years old and the youngest was 21 years old. Of the 100 participants in the study, 16 subjects presented with left sided CTS symptoms only, 24 subjects presented with right sided CTS symptoms only and 60 subjects presented with bilateral CTS symptoms (refer to chart 1). To add, 53 of the 100 subjects in the study (53%) also presented with cervical spine pain. The range of scores for the CTS questionnaire were -1 to 10 out of a total score of 10 for the questionnaire, where 10 indicated the most severe symptoms and 0 no symptoms (refer to Figure 1). The mean score for the clinical questionnaire was 5.02 with a standard deviation of 2.14.

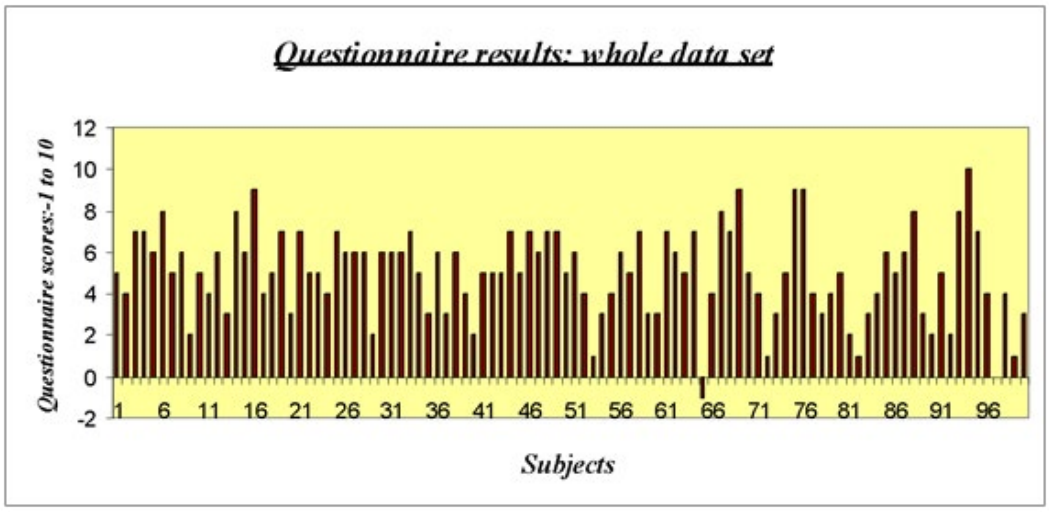

Figure 1: Overall Questionnaire Results for Each Subject

The scoring system for the Mediracer for severity of CTS was as follows:

- 0= No CTS (None)
- 1=Mild CTS
- 2=Moderate CTS
- 3=Severe CTS

193 recordings made with the Mediracer (100 participants and 2 recordings for each participant; one for the left side and one for the right). 7 missing recordings, 106 Mediracer scores revealed no CTS, 34 scores revealed mild CTS, 43 scores revealed moderate CTS, 10 scores revealed severe CTS and 7 'no results' obtained (refer chart 2). The mean score for the Mediracer was 0.777 with a standard deviation of 0.967. The overall correlation between the questionnaire results and the Mediracer results was found to be statistically significant ($p<0.05$).

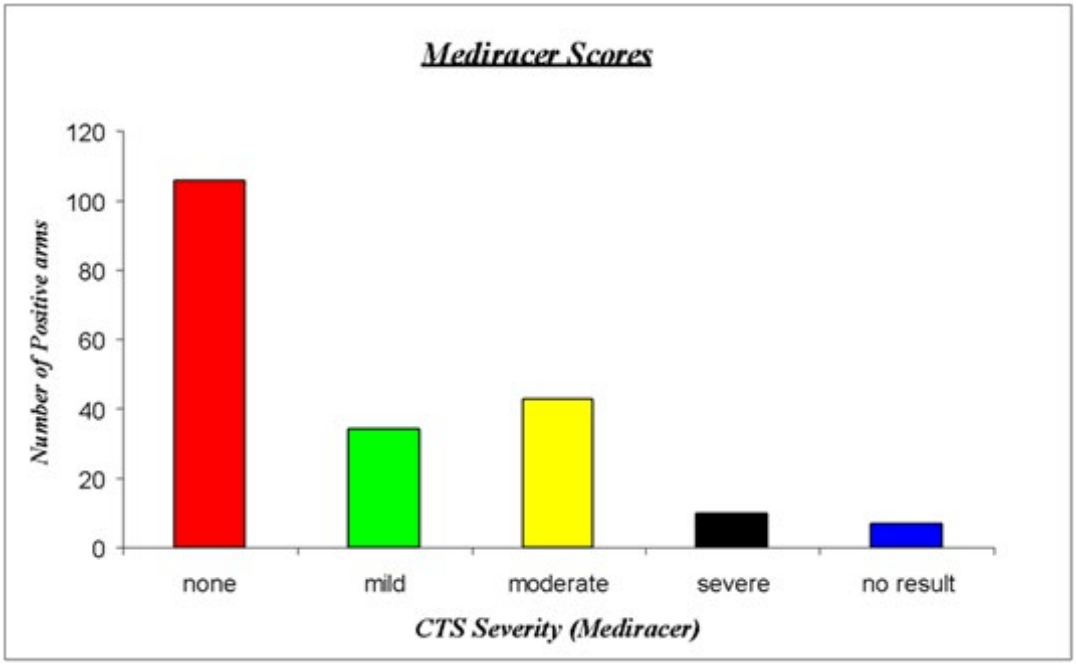

Figure 2: Severity of CTS in the Upper Limb Using the Mediracer

Symptom side:

• Left sided symptom results

16 subjects presented with left sided symptoms only. 16 results were gained from the questionnaire and 15 results from Mediracer (1 missing observation for the Mediracer). Questionnaire scores ranged from 0 to 9. The mean score for the questionnaire was 4.875 with a standard deviation of 2.825. The Mediracer results ranged from 0 (no CTS) to 2 (moderate CTS). There were 12 subjects with no CTS revealed, 1 subject with mild CTS, 2 with moderate CTS, 0 with severe CTS and 1 had no result obtained. The mean score for the Mediracer was 0.333 with a standard deviation of 0.724. The correlation between the questionnaire scores and Mediracer scores for subjects with left sided symptoms came out with a p-value of 0.81. With 16 subjects in this group the power was calculated at 0.104 (desired power is 0.8). With a post-hoc test performed the p-value came out as 0.475.

• Right Sided Symptom Results

There were 24 subjects that presented with right sided symptoms. The mean score for the questionnaire with this group was 4.542 with a standard deviation of 2.064. There were no missing results for this group. The Mediracer scores ranged from 0 (no CTS) to 3 (severe CTS). There were 11 subjects with no CTS revealed through the Mediracer, 4 with mild CTS, 7 with moderate CTS and 2 with severe CTS. The mean score for the Mediracer was 1 and the standard deviation was 1.217. The correlation between the questionnaire and the Mediracer scores for these subjects was calculated as p=0.23. The power calculation for this group of subjects (n=24) came out to be 0.093. With a post hoc test performed, the p-value was 0.17.

• Bilateral Symptom Results

There were 60 subjects that presented with bilateral symptoms. Participants often verbally described their symptoms to be worse on one side than the other or equal (spoken about in discussion section later). The range of scores for the questionnaire results for this group extended from 1 to 10. The mean score for the questionnaire results was calculated as 5.217 with a standard deviation of 1.932. There were 4 missing results for the Mediracer for this group. The Mediracer scores extended between 0 and 3. The Mediracer revealed that there were 57 subjects with no CTS identified, 24 with mild CTS, 27 with moderate CTS, 8 with severe CTS and there were 4 no results (refer below to chart 9). The mean score for the Mediracer results was 0.879 with a standard deviation of 0.997. The correlation between the questionnaire scores and the Mediracer scores for the participants presenting with bilateral symptoms was worked out to be p=0.107. With a group size of 60 participants (120 recordings), the power was calculated to be 0.436. A post hoc test resulted in a p-value of 0.072.

Gender:

• Male

From the 21 males assessed in the study, the mean questionnaire score was 4.762 with a standard deviation of 2.536. The questionnaire scores for the males ranged from -1 to 9. The Mediracer scores for the male participants ranged from 0 to 2. As each male had both their upper limbs tested with the Mediracer, there were to be 42 recordings however there were 2 "no results" obtained and thus there were 40 recordings noted. From the Mediracer, there were 28 "no CTS (none)" symptom results revealed 5 mild CTS symptom results, 7 moderate CTS symptom results obtained and 0 severe CTS symptom results. The mean score for the Mediracer was 0.475 with a standard deviation of 0.784. For the male subjects, a correlation value of p=0.71 was found with a power value of 0.360 (group size of 21 and 40 recordings; recordings for both right and left side with 2 missing observations). With the post hoc test performed, the p-value was calculated as P=0.11

• Female

With reference to the 79 female participants, the mean score for the questionnaires was 5.089 with standard deviation of 2.02. The results for the questionnaires completed by the female subjects ranged from 0 to 10. The mean score for the Mediracer assessments of the female subjects was 0.856 with a standard deviation of 0.996. The Mediracer results extended from 0 (no CTS) to 3 (severe CTS). As there were 79 female subjects, there were to be 2 readings per subject; one for the right side and one for the left, thus making up 158 readings. However, there were 5 missing readings (no results) with the female subjects therefore making a total of 153 Mediracer scores for the female subjects. There were 78 "no CTS (none)" results using the Mediracer, 29 mild CTS symptom results, 36 moderate CTS symptom results and 10 severe CTS symptom results. The correlation between the questionnaire scores and the Mediracer scores for the female subjects presented with a p-value of 0.012 with a power calculation of 0.338 (group size of 79 subjects and 153 recordings; recordings for both right and left side with 5 missing observations).

Ambiguous Symptom Results

Certain participants complained of unilateral symptoms (verbally and through the questionnaire), however when assessed with the Mediracer, positive CTS results were picked up not only on the side where the subject directed his/her complaints but also on the contralateral side (the side where the subject did not indicate verbally or through the questionnaire any CTS symptoms). These subjects, for the purpose of this research, are described as the ambiguous contralateral cases. Of the 40 subjects who expressed experiencing one sided symptoms (either right side only or left side only), 12 of these participants presented with ambiguous results through the Mediracer testing and 28 presented with standard unilateral results. Therefore, 40% of the unilateral complaints presented with contralateral CTS readings with the Mediracer. Thus, when taking the whole group of participants (100 subjects; unilateral cases and bilateral cases), 12 of the 100 presented with the ambiguous contralateral readings therefore 12% of the study sample, in total, displayed ambiguous contralateral results with assessment via the Mediracer, 28% revealed standard unilateral results and 60% revealed standard bilateral results (refer to figure 3).

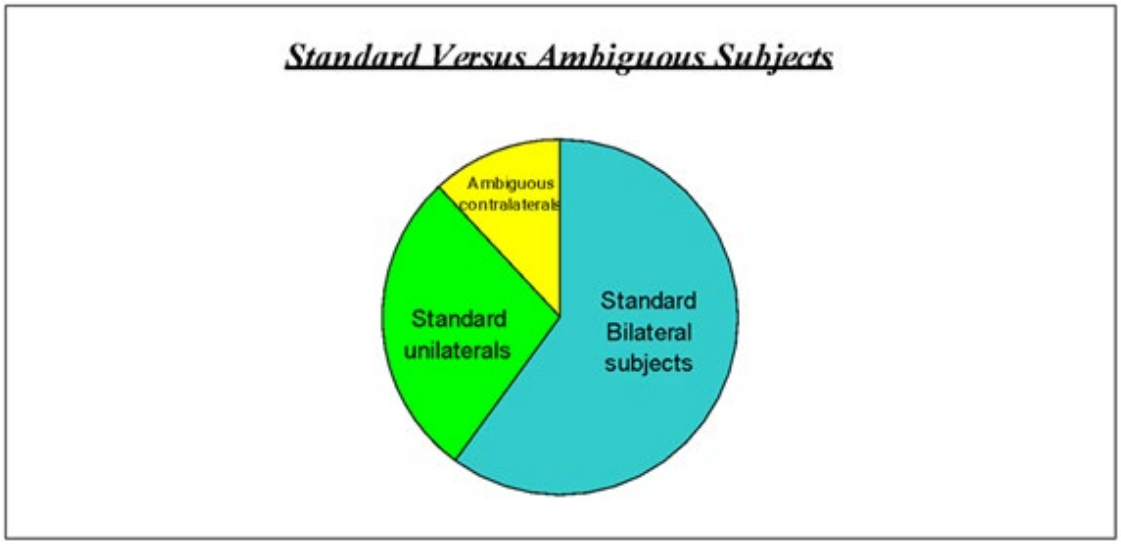

Figure 3: Ambiguous Results using the Mediracer

Discussion

Atroshi et al (1999) found that 1 in 5 symptomatic subjects would be expected to have CTS based on their clinical assessment and electrophysiological testing [20,52]. Padua, Padua, Aprile et al (1999) found that although women are more commonly affected by CTS, men experience greater severity neurophysiologically using NCS [4,27]. In the present study, however, women displayed the greater neurophysiological severity with reference to the usage of both the questionnaire and the Mediracer. Within the female group, the calculation of a significant correlation between the questionnaire and Mediracer scores was evident with a p-value of 0.012. The sample size of this group (female group) being significantly larger than the male group (79) may have been an important contributor to the significant correlation found within this group of subjects. Through analysis of the results for subjects in the current study when divided into groups based on symptomatic side, a lack of significance between questionnaire results and Mediracer results was present. This may be based on the groups being small and thus underpowered. However, when analysing the data as a whole (without separating it into groups based on symptomatic side), there is a significant correlation between the questionnaire scores and the Mediracer results. In the present research, 53 of the 100 subjects (53%) presented with concurrent cervical pain. Therefore, although the Boston Questionnaire was not utilised in the present study, interpretation of the questionnaire results needs to be viewed with caution as CTS symptoms associated with cervical pain may point in the direction of a more complex neuropathic pathology rather than a pure diagnosis of CTS [13]. Importantly, the significant correlation found between the questionnaire and Mediracer scores in the present research should still be interpreted with a critical analysis as subjective responses and biases from subject and examiner may have been present as these are commonly unavoidable. In a literature review first published in 1993 and then updated in 2002, The American Association of Electrodiagnostic Medicine (AAEM) concluded that median and motor NCS‘s identify CTS in patients with a high degree of sensitivity and specificity [16,14]. Challengers of the routine use of NCS, sustain their assertion that the tests are often redundant or irrelevant to the diagnosis and management of CTS [49].

Witt, Hentz and Stevens (2004) continue to assert that redundancy suggests that NCS results add no critical information to the clinical history and physical examination of patients with CTS. Witt, Hentz and Stevens (2004), in their research, focused on patients who presented with clinically suspected CTS but normal NCS results versus those with abnormal CTS results [49]. The researchers found that 25% of patients with clinically diagnosed CTS had normal NCS. In addition, there were 5 patients with normal NCS for the affected hand in which NCS results were positive (abnormal) on the contralateral side [49]. The above research by Witt, Hentz and Stevens (2004) may correlate to some of the findings in the present study where 12 subjects revealed ‘no CTS (0)‘ when assessed with the mediracer even though verbally and through the questionnaire, symptomology was acknowledged [49]. Conversely, some subjects who scored low with the questionnaire (low clinical symptoms of CTS) had results of ‘moderate CTS‘ severity. Therefore, importantly, either the accuracy of the questionnaire in terms of CTS severity must be questioned or/and the specificity and/or sensitivity of the Mediracer must be reviewed. As mentioned in the results section, certain subjects presented, via the Mediracer, with positive CTS results also on the contralateral side to the symptomatic side (the ambiguous cases), as with Witt, Hentz and Stevens (2004) [49]. These results may indicate central changes in the subjects‘ nervous system, for example mirroring. In relation to the above, Upton and McComas (1973) described the double crush in nerve entrapment syndromes [29]. A cervical lesion may explain the variable nerve pathology at the wrist and the proximal reduction of speed of impulse conduction in CTS patients [29]. If the nerve root damage

led to the production of distal axonal lesions, damage to several cervical roots could lead to multiple entrapment pathologies [10,29]. The essence of this theory suggests that neural function is impaired because single axons, having been compressed in one region, become greatly vulnerable to damage and pathology at another site [29]. Kwon, Hwang and Yoon (2006) assert that the most frequent clinical example of the double crush hypothesis is a heightened predisposition to CTS in patients with cervical radiculopathies [20]. Although not all the ambiguous cases in the current study presented with cervical pathology, some did have cervical symptoms which may correspond to the above theory presented by Upton and McComas (1973) and Kwon, Hwang and Yoon (2006) [20,29]. This may also account for the ambiguous group.

It is difficult to understand how cervical radiculopathy can have an impact on distal sensory NCS‘s as the injury in cervical radiculopathy is proximal to the dorsal root ganglion (DRG) and therefore would not be expected to result in distal dysfunction of the sensory nerves, which is a key finding in CTS [32,53]. However, importantly it must be noted, that whether or not a lesion is proximal to the DRG, complex central changes can certainly occur, which as a result can have an impact on the distal sensory nerves and therefore this hypothesis may account for the contralateral Mediracer findings. Within the bilateral symptomatic group, a significant correlation was found between the questionnaire scores and Mediracer scores. Although a p-value of 0.047 was revealed for the right symptomatic hand group, this needs to be interpreted with caution. The left symptomatic side group did not have a significant correlation between the questionnaire and Mediracer scores (p=0.898). When reviewing the above results for the left- and right-hand subdivisions of the bilateral group, there are possible explanations that need to be considered when exploring these results. Firstly, the question of whether there is a difference noted between the left and right when assessed with nerve conduction tests needs to be asked. Overall, there were 60 subjects in the bilateral group, thus making 30 right hands and 30 left hands (excluding the 4 missing observations) and therefore a difference in the numbers of left and right hands in the nerve conduction testing cannot be the explanation; velocity differences cannot be an explanation due to equal left and right-side numbers. Another possible explanation of the paradoxical results is whether or not gender could play a role in these particular results. However, this appears not to be the case as there are equal amounts of left and right hands in females as in men. Looking at a physiological error as the reason for the above paradoxical results may be of sufficient explanation. When reviewing the data, more subjects who had bilateral symptoms stated that they experience greater severity of symptoms on the right side than on the left side. This may explain the interesting result on the right side (described above). Another explanation for the results is that of an experimental error. This may be a sequencing error in terms of not testing the right side and left side consistently in the same order with the Mediracer. Secondly, the technique in which the assessor tests the specific side may be different from the manner used to examine other side due to the hand that the assessor uses to complete the testing with; the direction/angle at which the assessor tests the subjects` right side may be different to that of the left side and vice versa as a result of an error in assessing technique and thus experimental error being brought about.

4. Limitations

A larger sample size should be instituted so as to increase the size of both the left and right sided symptomatic group individually. This would increase the power of these specific groups within the study. Secondly, it may be plausible to have completely separate studies for left sided symptomatic groups and right sided symptomatic groups and in turn have larger samples for each of these groups so to once again increase the power of these specific groups. Controlling for experimental error (which was perhaps evident in the current study) in future studies is advisable so as to perhaps establish results that may reveal greater consistency and accuracy in certain important areas of the research. It is suggested that future research perhaps further explores the usage of the Mediracer with polyneuropathies in terms of the instrument‘s sensitivity and specificity. The possibility of future research investigating the relationship between length of time of CTS symptoms and CTS questionnaire scores, in greater detail, may be a useful task to undertake as this may provide further knowledge around certain paradoxes within the data around the questionnaire scores and length of time that the subject has experiences CTS symptoms. Finally, further investigations into central nervous system changes within certain subjects should also be conducted to provide greater in-depth information regarding various appropriate subjects in the sample.

5. Conclusion

In conclusion, the present study assessed the relationship between a questionnaire for CTS and the Mediracer instrument in evaluating severity of CTS. The research revealed that when analysing the whole data set, there is a significant correlation between the scores of the questionnaire and the Mediracer results. However, when the whole sample was broken down into groups (symptomatic side/s, gender), generally no significant correlations were found based on various possible reasons described earlier. Finally, the ambiguous results have been explained in term of possible central nervous system changes in these subjects; perhaps due to double crush syndrome taking place.

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