Functional status measured by Levine questionnaire in surgically and conservatively treated patients with carpal tunnel syndrome regarding nerve conduction studies

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AIM: *To evaluate and compare the functional status in surgically treated patients with Carpal tunnel syndrome (CTS) compared with those treated conservatively by Levine Questionnaire (LQ) in relation to electroneurographic findings.*
METHODS: *The prospective study included 80 patients with diagnosed CTS. Patients were assessed clinically and electrophysiologically. The main outcome measures were sensory latency of median nerve (SL II), and terminal (distal) motor latency of median nerve (TML). For the assessment of functional status we performed Levine Questionnaire (LQ) scoring examination which was divided in two sections: symptoms severity scale (SSS) and functional status scale (FSS). Regarding treatment options patients were divided into 2 groups: group that underwent surgical procedure (Group A) and group that underwent only conservative treatment (Group B). Patients were assessed neurophysiologically twice: before treatment and 12 months after treatment.*
RESULTS: *There is significant increase in LQ-FSS (p=0.021) and LQ-SSS (p=0.038) scores for increased TML and significant increase of LQ-SSS scores (p=0.027) for increased SL II for Group A, while in Group B, LQ-FSS (p=0.034) and LQ-SSS (p=0.018) were significantly increased in patients with increased SL II. After treatment there was significant increase in LQ-FSS (p=0.037) and LQ-SSS (p=0.041) scores for increased SL II for Group B, while in Group A after treatment, we have noticed non-significant differences both regarding TML and SL II values.*
CONCLUSION: *We have demonstrated the benefits of surgical treatment and better functional improvement with symptoms reduction particularly in more severe cases of patients with CTS.*

KEY WORDS: Carpal tunnel syndrome, Conservative treatment

Introduction

Carpal tunnel syndrome (CTS), caused by compression of the median nerve in the wrist area is the most common compressive neuropathy in adults, most frequently between 40 and 60 years of age, with women to men ratio of 3:1 [1]. Typical manifestations are numbness of the index and middle finger, sometimes with a pain, which usually occurs more often at night and wakes from sleep. Thenar muscles atrophy and weakness is seen as a late sign of disease [1]. A combination of symptoms, signs and diagnostic tests should be taken into account when the diagnosis of CTS is made. The presence or absence of characteristic physical findings has limited diagnostic value [1-3].
Median nerve motor and sensory nerve conduction studies (NCSs) are used to confirm clinical diagnosis of CTS

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in patients with a high degree of sensitivity and specificity [4-6]. If not timely recognized, untreated CTS might lead to the permanent damage of the median nerve [7].
The conservative treatment of CTS is preferred in those patients with mild to moderate symptoms. It includes splinting, application of non-steroidal anti-inflammatory drugs and/or steroids, along with physiotherapy [8].
Surgical treatment is reserved for more severe forms of CTS, and includes two approaches: open carpal tunnel release and endoscopic carpal tunnel release that are shown to be similarly effective regarding functional status and symptoms improvement [9].
The aim of this study was to evaluate and compare the functional status in surgically treated patients with CTS compared with those treated conservatively by Levine Questionnaire (LQ) in relation to electroneurographic findings.

Material and Methods

The prospective study included 80 patients with diagnosed Carpal tunnel syndrome (CTS). Prior inclusion in the study, participants were informed about study protocol and consent was obtained. The study was approved by Institutional Review Board, and was conducted according to the declaration of Helsinki.
Patients with prior injuries or surgery on the upper limbs and diseases that can cause peripheral neuropathy, were excluded from the study.
Patients were assessed clinically and electrophysiologically. The main outcome measures were sensory latency of median nerve (SL II), and terminal (distal) motor latency of median nerve (TML).
For the confirmation of CTS diagnosis we followed recommendations for median-ulnar comparison studies that are measured on IV digit, with equal distance between stimulation (wrist area) and detection (IV digit) electrodes for both sensory median evaluation and sensory ulnar evaluation [4]. The significant differences between median and ulnar latencies are considered to be ≥0.5ms (for CTS prolonged median latency) [4].
Terminal motor latency (TML) for median nerve was generated by stimulation of median nerve at the wrist and detection at the abductor pollicis brevis muscle, with distance between these two sites of 7 cm, while sensory latency (SL II) for median nerve was generated by antidromic technique, stimulating median nerve at wrist and detection on II digit, with distance between these two sites of 13 cm [4]. Increased TML and SL II for median nerve were calculated according to normative, where normal values of nerve conduction studies (NCS) in adults for TML of median nerve are ≤4.4ms, and for SL II of median nerve are ≤3.5ms [4].
For the assessment of functional status we performed Levine Questionnaire (LQ) scoring examination. LQ is self-administered questionnaire divided in two sections. The symptoms severity scale (SSS) is 11 questions and evaluates symptoms regarding severity, frequency, time and kind. The functional status scale (FSS) is 8 questions and evaluates how the syndrome affects daily life [10].
Regarding treatment options patients were divided into 2 groups: group that underwent surgical procedure - standard open carpal tunnel release (Group A) including 42 patients (26 subjects were with increased TML and 32 with increased SL II), and group that underwent only conservative treatment such as physical therapy – application of physical agents (Group B) including 38 patients (17 subjects with increased TML and 26 with increased SL II). Surgical procedure was performed as an open decompression, with longitudinal sectioning the transcarpal ligament (TCL) that has been shown to increase the volume of carpal canal, consistently reducing patient's symptoms within a relatively short period of time. This technique affords full inspection of the TCL and the contents of the carpal canal.
Patients were assessed neurophysiologically twice: before treatment and 12 months after treatment.

Statistical Analysis

Mann Whitney U test was used for comparisons of FSS and SSS mean values domains of LQ regarding the presence of increased TML and SL II values. Same statistical test was performed for comparisons between evaluated groups and comparisons of LQ-FSS and LQ-SSS values before and after treatment. Statistical significance was set at $p<0.05$.

Results

In table I we have presented LQ values with regards to the presence of increased and decreased TML and SL II in different groups of patients before treatment. There is significant increase in LQ-FSS (p=0.021) and LQ-SSS (p=0.038) scores for increased TML and significant increase of LQ-SSS scores (p=0.027) for increased SL II for Group A (Table I). Regarding Group B LQ-FSS (p=0.034) and LQ-SSS (p=0.018) were significantly increased in patients with increased SL II (Table I).
In table II we have presented LQ values with regards to the presence of increased and decreased TML and SL II in different groups of patients after treatment. There is significant increase in LQ-FSS (p=0.037) and LQ-SSS (p=0.041) scores for increased SL II for Group B (Table II). Regarding Group A after treatment, we have noticed non-significant differences in scores of LQ-FSS (p>0.05) and LQ-SSS (p>0.05) both regarding TML and SL II values (Table II).
In Group A for LQ-FSS there was significant decline of score after treatment for those with increased TML (p=0.019) and with physiological TML (p=0.042), while

TABLE I - *LQ values regarding TML and SL II before treatment.*

Parameters	Group A LQ-FSS (MV±SD)	p value*	Group B LQ-FSS (MV±SD)	p value*
Increased TML	2.67±0.79		2.32±0.77	
Physiological TML	2.09±0.73	0.021	2.14±0.64	0.098
Increased SL II	2.17±0.66	0.317	2.82±0.97	0.034
Physiological SL II	2.14±0.89		2.35±0.61	
	LQ-SSS	LQ-SSS		
Increased TML	2.83±0.51		2.74±1.11	
Physiological TML	2.29±0.56	0.038	2.46±0.64	0.263
Increased SL II	2.63±0.37		3.27±0.71	
Physiological SL II	2.31±0.60	0.027	2.26±0.67	0.018

*Mann Whitney U-test

TABLE II - *LQ values regarding TML and SL II after treatment.*

Parameters	Group A LQ-FSS (MV±SD)	p value*	Group B LQ-FSS (MV±SD)	p value*
Increased TML	2.12±0.81		2.54±0.63	
Physiological TML	1.75±0.77	0.053	2.20±0.75	0.210
Increased SL II	2.21±0.36		2.94±0.15	
Physiological SL II	2.27±0.88	0.692	2.19±0.68	0.037
	LQ-SSS	LQ-SSS		
Increased TML	2.27±0.44		2.44±0.72	
Physiological TML	2.31±0.60	0.524	2.41±1.02	0.847
Increased SL II	2.18±0.32		2.89±0.63	
Physiological SL II	2.21±0.56	0.328	2.30±0.89	0.041

*Mann Whitney U-test

for LQ-SSS, significant decline of score was noticed in patients with increased TML (p=0.027) and increased SL II (p=0.015) (Table III). In Group B for LQ-FSS there was significant decline of score after treatment for those with physiological SL II (p=0.032), while for LQ-SSS, significant decline of score was noticed in patients with increased TML (p=0.047) and increased SL II (p=0.022) (Table III).

Before treatment there were significant differences between patients of Group A and Group B for LQ-FSS for those with increased TML (p=0.048) and for those with increased SL II (p=0.003) and physiological SL II (p=0.019), while for LQ-SSS, significant difference was noticed in patients with increased SL II (p=0.008) (Table IV). After the treatment there were significant differences between patients of Group A and Group B for LQ-FSS for those with increased TML (p=0.048) and physiological TML (p=0.031) and for those with increased SL II (p=0.019), while for LQ-SSS, significant difference was noticed in patients with increased TML (p=0.023) and increased SL II (p=0.039) (Table IV).

TABLE III - *Differences in LQ scores in evaluated patients before and after treatment.*

Parameters	Group A (p value)* Before/After treatment LQ-FSS	Group B (p value)* Before/After treatment LQ-FSS
Increased TML	0.019	0.237
Physiological TML	0.042	0.458
Increased SL II	0.095	0.064
Physiological SL II	0.118	0.032
	Before/After treatment LQ-SSS	Before/After treatment LQ-SSS
Increased TML	0.027	0.047
Physiological TML	0.462	0.218
Increased SL II	0.015	0.022
Physiological SL II	0.102	0.165

*Mann Whitney U-test

TABLE IV - *Differences in LQ scores in evaluated patients from different study groups.*

Parameters	Group A (p value)* Before treatment LQ-FSS	Group B (p value)* After treatment LQ-FSS
Increased TML	0.048	0.024
Physiological TML	0.562	0.031
Increased SL II	0.003	0.019
Physiological SL II	0.019	0.074
	Group A/Group B LQ-SSS	Group A/Group B LQ-SSS
Increased TML	0.627	0.023
Physiological TML	0.254	0.413
Increased SL II	0.008	0.039
Physiological SL II	0.075	0.096

*Mann Whitney U-test

Discussion

Previously it was noticed that solely none of physical signs that are commonly used in diagnosis of CTS, is sufficiently sensitive, thus so far there is no consensus on which combination of such signs is highly accurate for CTS diagnosis [11]. The use of Levine Questionnaire for patients with CTS is justified since, it is highly reproducible and internally self-administered questionnaire for the purpose of symptoms severity assessment [10]. It was noticed as well that LQ compared to other questionnaires has highest validity due to strong correlation with all functional measures [12]. However, in the study of Mondelli et al, it was pointed out that presurgical scores obtained by Boston (Levine) questionnaire could not be reliable in prediction of improvement degree of symp-

toms and functional status after surgery [13]. Given the fact that LQ scores and nerve conduction velocities are complementary and easy to perform [13], in our study we have divided patients for assessment into two groups regarding TML and SL II values (physiological and increased).

Previous studies stressed-out favorable outcome of patients that were treated by open carpal tunnel release method, with significant improvement in functional status and symptoms reduction [14,15]. In the study of Gerogiew et al [16], it was stated that the most of improvement regarding functional status and symptoms reduction is for patients with severely disturbed baseline conductions in the median nerve. Our findings are consistent with previous reports, where surgical treatment gives significant functional improvement for group with increased TML of median nerve, while significant improvement in symptoms reduction was noticed for group of patients with increased both TML and SL II values on electrodiagnostic examination.

So far, there are still conflicting conclusions regarding conservative treatment for patients with CTS. In the study of Gerritsen et al [17] it was pointed out that considering efficacy of conservative treatment for CTS patients, there are still little data. The other study of LeBlanc and Cestia [18], stress out positive short term effects of conservative treatment, while there is not enough evidence in support of long-term benefits. Pilot study of Maddali Bongi et al [19] indicated that implementation of manual therapy for CTS patients has benefits in functional improvement and symptoms reduction. The possible explanation for conflicting effects of conservative treatment might be in the fact that different studies evaluate effects of different conservative treatment modes on functional status and symptoms severity in CTS patients.

In our study, we have noticed from the results of conservatively treated group, that such treatment is more effective in symptoms improvement rather than functional improvement regarding SL II changes on median nerve, although both domains (functional and symptoms) showed significant improvement.

In the light of dilemma concerning conservative versus surgical treatment, it should be underlined that conservative treatment although in some cases not curative, brings to sufficient relief for certain group of patients. Thus, surgical treatment even though is not first line treatment, the one is definite for patients with CTS [20]. The benefits of surgical treatment were stressed-out previously in comparison to non-surgical treatment for patients with CTS, particularly in functional improvement and symptoms reduction after 12 months post surgery [21]. In the performed study of success rate comparisons between splinting and surgery treatment options for CTS [22], better results were obtained 3 months after interventions in the group of patients which underwent surgery, with increase of success rate 18 months after surgery versus splinting. In the study of Shi and MacDermid [20] it was addressed that positive effects of conservative treatment are maximal at 3 months after treatment, while for those which underwent surgical treatment such effects could increase until 12 months post surgery. However, it should be stressed-out that different variables influence recovery in terms of symptoms reduction and functional improvement for patients with CTS. We have demonstrated that for patients with CTS that underwent surgery compared to those who were included into conservative treatment, significant decline in LQ scores for functional domains were achieved regardless the TML findings for median nerve, and for those with increased SL II. Significant improvements in symptoms reduction measured by LQ, were achieved for those who underwent surgery versus solely conservative treatment in the groups with increased TML and SL II for median nerve. Such findings stress out benefits of surgical treatment and better functional improvement with symptoms reduction particularly in more severe cases. Therefore, individual patient assessment both functional and clinical along with ones expectations should be implemented when making decision for optimal treatment type.

Riassunto

Con questo studio si è inteso valutare e paragonare lo stato funzionale di pazienti trattati chirurgicamente per una sindrome del tunnel carpale (CTS) con quello di pazienti trattati conservativamcntc, basandosi sul Questionario di Levine (LQ) in relazione ai rilievi elcttroneurografici.

Si è trattato di uno studio prospettico su 80 pazienti con diagnosticata CTS, studiati clinicamente e con esame elettrofisiologico. Le principali misure per determinare il risultato sono stati la latenza sensoriale del nervo mediano (SL III), e la latenza motoria terminale (distale) del nervo mediano (TML). Per valutare lo stato funzionale ci siamo avvalsi del punteggio del Questionario di Levine (LQ) suddiviso in due sezioni: una scala di gravità dei sintomi (SSS) ed una scala dello stato funzionale (FSS). Per quanto riguarda le scelte del trattamento i pazienti sono stati divisi in due gruppi: gruppo A dei pazienti sottoposti a trattamento chirurgico, e gruppo B dei pazienti sottoposti al solo trattamento conservativo.

Tutti i pazienti sono stati valutati due volte con esame neurofisiologico, prima del trattamento e 12 mesi dopo. Risultato: Si è rilevato un significativo incremento nel punteggio LQ-FSS (p=0,021) e di quello LQ-SSS (p=0,038) per incremento della TML ed un significativo incremento del puntuggio LQ-SSS (p= 0,027) per aumento del SL II nel gruppo A, mentre nel gruppo B il punteggio LQ-FSS (p=0,034) e quello LQ-SSS (p=0,018) sono risultati significativamente aumentati nei pazienti con accresciuta SL II.

Dopo il trattamento c'è stato un significativo incremento nel punteggio LQ-FSS (p=0.037) e LQ-SSS (p=0,041) per accresciuta SL II nel gruppo B, mentre nel gruppo A dopo trattamento non è stata rilevata alcuna differenza significativa sia in relazione ai valori di TML e SL II. Si è dimostrato così il beneficio conseguito con il trattamento chirurgico con migliore risultato funzionale e riduzione della sintomatologia specie nei casi più gravi di sindrome del tunnel carpale (CTS).

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