Improvement in Sleep Quality after Carpal Tunnel Release

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ABSTRACT

Introduction: Sleep disturbances caused by night pain and paresthesia are usual symptoms in carpal tunnel syndrome (CTS), and are often the cause of medical consultation.

Objective changes following the Carpal Tunnel Release (CTR) have been thoroughly analyzed. However, evidence related to improvement in sleep quality is lacking.

We consider that the immediate improvement in sleep quality is directly related to CTR. The main purpose of this study is to assess these changes following this procedure. The secondary objective is to evaluate if the severity of the median nerve compression or patient-related factors could have an impact on sleep quality. **Materials and Methods:** Prospective case study of 67 patients diagnosed with CTS who underwent CTR procedure. We grouped all cases based on age, sex, and nerve conduction study (NCS) results. Sleep quality was evaluated with the Athens Insomnia Score before surgery and in the fourth follow-up day, asking specifically about symptoms from the first night after the procedure. **Results:** Sleep disorders were found in 74.62% of cases before surgery. After CTR, sleep quality improved in all cases ($p<0.05$). We found no relation between sleep quality improvement and sex, age, or NCS severity. **Conclusions:** CTR is commonly indicated to stop nerve damage, and to improve sensitive and motor symptoms. However, sleep disturbances are not the main indication for it, even if it is a frequent reason for medical consultation. Sleep quality improves from the first night after CTR, and this outcome is independent of age, sex, or severity of CTS.

Keywords: Carpal tunnel syndrome; carpal tunnel release; insomnia; sleep disturbance.
Level of Evidence: II

Mejoría del sueño en los pacientes operados por síndrome del túnel carpiano

RESUMEN

Introducción: Los pacientes con síndrome del túnel carpiano suelen tener síntomas nocturnos que alteran la calidad del sueño y, muchas veces, son el motivo de consulta. Se estudiaron en profundidad los cambios objetivos luego de la liberación del túnel carpiano. Sin embargo, la evidencia sobre la mejoría del sueño tras la cirugía es escasa. Consideramos que la mejoría de la calidad del sueño está directamente relacionada con el procedimiento; nuestro objetivo primario fue comprobarlo. Como objetivo secundario se evaluó si los cambios en el sueño varían según factores constitucionales o de severidad del síndrome del túnel carpiano. **Materiales y Métodos:** Serie prospectiva de 67 casos con síndrome del túnel carpiano e indicación de cirugía. Se dividieron grupos según edad, sexo y severidad de síndrome por electrodiagnóstico. Se evaluó la calidad del sueño con la Escala de Insomnio de Atenas antes de la cirugía y cuatro días después. **Resultados:** El 74,62% de los pacientes tenía alteraciones de la calidad del sueño antes de la cirugía. Se comprobó una mejoría significativa en la calidad del sueño después de la operación, en todos los casos ($p <0,05$). No hubo diferencias significativas en los resultados entre los grupos. **Conclusiones:** Clásicamente el éxito de la liberación del túnel carpiano se resume en los cambios sensitivo-motores. Sin embargo, no se apunta a la mejoría de la calidad del sueño, aunque sea el generador de la consulta. La descompresión del túnel carpiano mejora el sueño, independientemente de la edad, el sexo o la gravedad del cuadro.

Palabras clave: Síndrome del túnel carpiano; liberación del túnel carpiano; insomnio; alteración del sueño.
Nivel de Evidencia: II

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INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common compressive neuropathy, with an annual incidence of 3% to 6% of the population.[1] It was described by Paget in 1913, who reported compression of the median nerve secondary to a fracture at the distal end of the radius. It is defined as compression of the median nerve in the wrist as it passes through the osteofibrous canal called the carpal tunnel.

Some characteristic symptoms are paresthesia and neuropathic pain in the sensory territory of the median nerve (volar side of the first three fingers and volar radial edge of the fourth), sometimes with proximal extension to the forearm and arm. In more severe cases, thenar weakness or atrophy is added due to the involvement of the abductor pollicis brevis. Provocation tests that increase sensory symptoms, such as percussion (Tinel),[2] compression (Durkan),[3] or wrist flexion (Phalen)[4] have been described. The scratch collapse test was recently described, which stimulates the skin of the affected area.[5]

The sensory symptoms typically increase during the night and at the moment of awakening, which leads to a disturbance of sleep and daytime performance. The proposed factors include the flexion of the wrists when sleeping, increased hydrostatic pressure within the carpal tunnel in the decubitus position, and the lateral decubitus position, especially on the affected side.[6,7]

Diagnosis of CTS is mainly based on clinical observation of symptoms and physical examination. It is supplemented for confirmation and prognosis with electrodiagnostic studies.[8]

Treatment of CTS generally begins with conservative measures including the use of wrist immobilizers or glucocorticoid infiltrations. However, the only treatment that provides lasting results is decompression of the carpal tunnel by opening the flexor retinaculum in the wrist.[9]

The objectives of surgical treatment of CTS are to stop the compression process in the median nerve and improve symptoms related to the sensitivity and strength of thenar eminence in the short and long term.[9] However, the improvement in sleep quality is not as consistent within the proposed goals. In our practice, we have observed that night pain disappears after surgery, with a frank improvement in the quality of sleep.

The primary objective of our study was to verify whether the surgical release of the carpal tunnel immediately improves sleep quality.

The secondary objective was to assess whether there are constitutional (age, sex) or CTS severity factors that could modify the outcome.

MATERIALS AND METHODS

Between June 2019 and March 2020, 70 patients with CTS diagnosed by clinical and electrodiagnostic findings underwent surgery in the Upper Limb Surgery Unit of our Hospital.

A prospective and longitudinal intervention study was carried out during the period described. The inclusion criteria were: patients over 18 years of age with clinical diagnosis and electrodiagnosis of CTS, in whom conservative treatment failed (night immobilization of the wrist in a neutral position, physiotherapy) and who had consented to surgery. Patients with acute CTS, symptomatic hand surgeries, neurological diseases, suspected double compression syndrome, bilateral CTS, or scheduled for combined procedures were excluded. Associated comorbidities (diabetes, rheumatoid arthritis, hypothyroidism, obesity) were recorded.

The clinical evaluation included the criteria recommended by Graham et al. in 2006,[10] which include pathological history, paresthesia in the dermal territory of the distal median nerve, nocturnal symptoms, sensitivity upon physical examination, the comparative strength of the abductor pollicis brevis, and positive provocation tests (Tinel, Phalen, Durkan). We added the scratch collapse test. To confirm the diagnosis, classification, and prognosis, electrodiagnostic studies were always requested. We classified the carpal tunnel syndrome into mild, moderate, and severe, according to the electromyographic assessment of Werner and Andary (Table 1).[11]

Sleep quality was evaluated using the Athens Insomnia Scale (AIS) described in 1995 by Soldatos,[12] and validated for use in the International Classification of Diseases (ICD-10),[13] as well as in Spanish [14] (Annex). The questionnaire consists of eight questions, the first five are aimed at assessing the quality of sleep and the last three questions are for daytime performance after sleep. Each question is answered on a scale of four options (0-3 points), the more severe the symptom, the higher the result. They are listed as follows: sleep induction, night awakenings, final awakening sooner than desired, total sleep duration, feeling of overall sleep quality, feeling of well-being during the day, feeling of physical and mental performance during the day, and drowsiness during the day.

Table 1. Severity of carpal tunnel syndrome according to Werner and Andary[11]

	Mild	Moderate	Severe
Sensory latency	Altered	Altered	Altered
Motor latency	Normal	Altered	Altered
Sensory/motor amplitude	Normal	Normal	Altered
Fibrillation	-	-	+
Altered MUP	-	-	+

Annex. Athens Insomnia Scale[20,21]

Athens Insomnia Scale

Date:
Patient:
Age:
Instructions
This scale is intended to record your own assessment of any sleep difficulty you might have experienced. Please, check (by circling the appropriate number) the items below to indicate your estimate of any difficulty.

A) Sleep Induction (time it takes you to fall asleep after turning-off the lights).
- 0. No problem
- 1. Slightly delayed
- 2. Markedly Delayed
- 3. Did not sleep at all

B) Awakenings during the night
- 0. No problem
- 1. Minor problem
- 2. Considerable problem
- 3. Serious problem or did not sleep at all

C) Final awakening earlier than desired
- 0. Not earlier
- 1. A little earlier
- 2. Markedly earlier
- 3. Much earlier or did not sleep at all

D) Overall quality of sleep (no matter how long you slept)
- 0. Satisfactory
- 1. Slightly unsatisfactory
- 2. Markedly unsatisfactory
- 3. Very unsatisfactory or did not sleep at all

E) Sense of well-being during the day
- 0. Normal
- 1. Slightly decreased
- 2. Markedly decreased
- 3. Very decreased

F) Functioning (physical and mental) during the day
- 0. Normal
- 1. Slightly decreased
- 2. Markedly decreased
- 3. Very decreased

G) Sleepiness during the day
- 0. None
- 1. Mild
- 2. Considerable
- 3. Intense

The initial evaluation was performed in the office before surgery, by asking the patient about their symptoms during the last month. The postoperative evaluation was carried out on the fourth day of surgery, thus reducing the information bias. The patient was asked about the symptoms suffered from the first night after surgery. We interpreted a value greater than 3 as altered sleep.

It was decided not to include subjective evaluations of general satisfaction or well-being in the series, since the evaluation was limited to the first few days after surgery in which there is pain and inflammation related to the procedure that could confuse the result.

The surgery was always carried out by traumatologists specialized in hand and upper limb surgery of our hospital, with knowledge and training in the subspecialty.

In all cases, decompression of the carpal tunnel was performed using the conventional open technique according to previous descriptions.[15] No epineurotomy or endoneurolysis was performed in any of the cases. After surgery, a soft-wrap bandage was placed, free movement of the 'unused' hand was stimulated, and patients were asked to return on the fourth day for the assessment of wounds and sleep as described above.

The SPSS v. 26.0 program (SPSS Inc., Chicago, Ill, USA) was used for the statistical analysis. The results were analyzed before and after surgery with the Wilcoxon test for non-parametric tests for total AIS scores, as well as for its subcategories. The results were compared by sex using the Mann-Whitney test, and by age (<60 years and >60 years) using the NPAR and Mann-Whitney tests. Comparisons related to the degree of severity of the CTS were made using the NPAR and Kruskal-Wallis tests. A p value <0.05 was considered statistically significant.

RESULTS

67 of the 70 CTS cases operated within the indicated period were included; one patient with compression in both carpal tunnels and another patient with carpal tunnel and concomitant homolateral cervical radiculopathy were excluded. The constitutional data are shown in Table 2.

Table 2. Constitutional data

Average age	Sex		Electrodiagnostic			Comorbidities		
	Women	Men	Mild	Moderate	Severe	Diabetes	Hypothyroidism	Rheumatoid arthritis
65 years old	44	23	20	29	13	16	12	2

74.62% of patients (50/67) had subjective sleep disturbances (AIS ≥3) before surgery. Immediately after carpal tunnel release, a statistically significant improvement (p <0.05) was observed in all cases in sleep quality according to AIS, with a 4.63-point decrease in the average score (range 6.28-1.67). The improvement was consistent in the eight variables included in the scale (p <0.05) (Figure 1).

When evaluating changes in preoperative and postoperative AIS according to constitutional and severity groups (gender, age or severity), a similar improvement was observed in all cases, with no statistically significant differences within each group (p = 166, p = 105, p = 0.831, respectively) (Figure 2).

DISCUSSION

As already described, the primary objective in the surgical treatment of CTS is to stop nerve degeneration secondary to chronic compression, making it possible to partially or completely restore thenar strength and sensitivity in the territory of the median nerve. Therefore, the success of a treatment is reflected in the achievement of objective results.

Despite this, the severity of the condition means that the results do not always meet the patient's expectations. Establishing realistic objectives before treatment ensures greater patient satisfaction and reduced chances of a subsequent conflict.[16]

In patients with severe CTS, it has been found that despite not achieving an objective recovery of thenar strength or sensitivity, self-perceived satisfaction at 6 months and a year after surgery was high.[17] This could be explained in part, if we understand that, many times, what motivates the patient to consult are subjective factors, such as "improving the quality of life", "not feeling pain", or "sleeping again".[18]

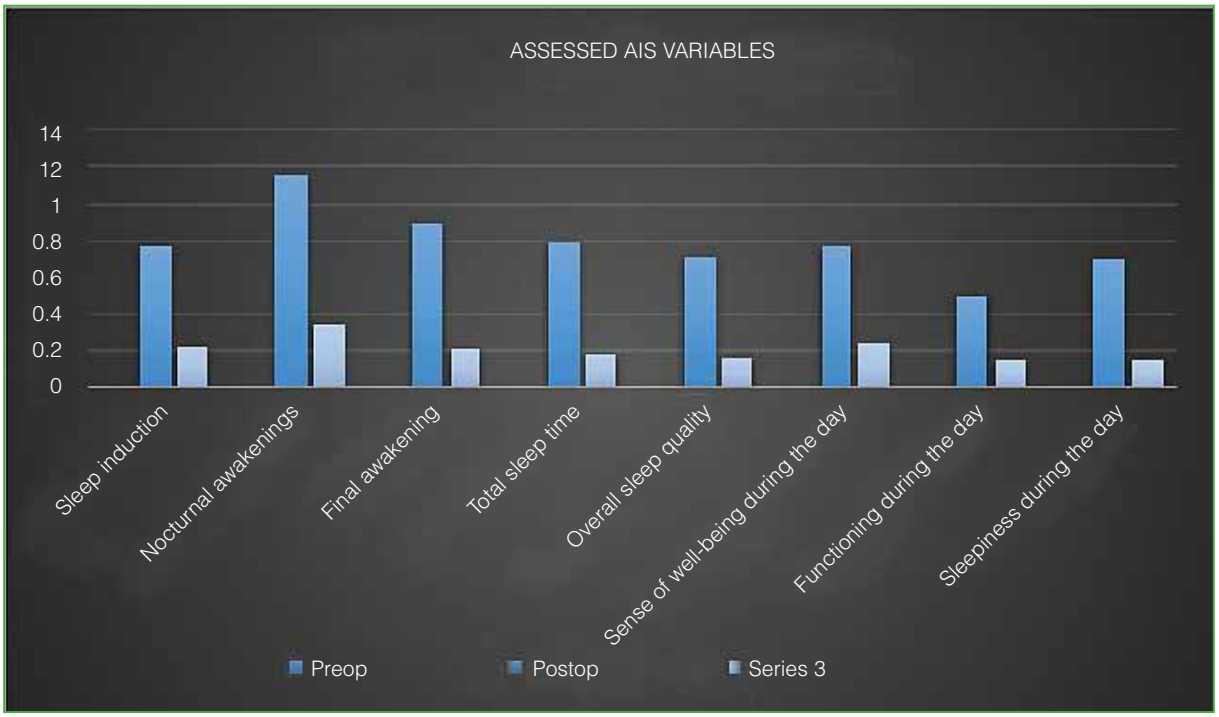

Figure 1. Results of the variables evaluated with the Athens Insomnia Scale

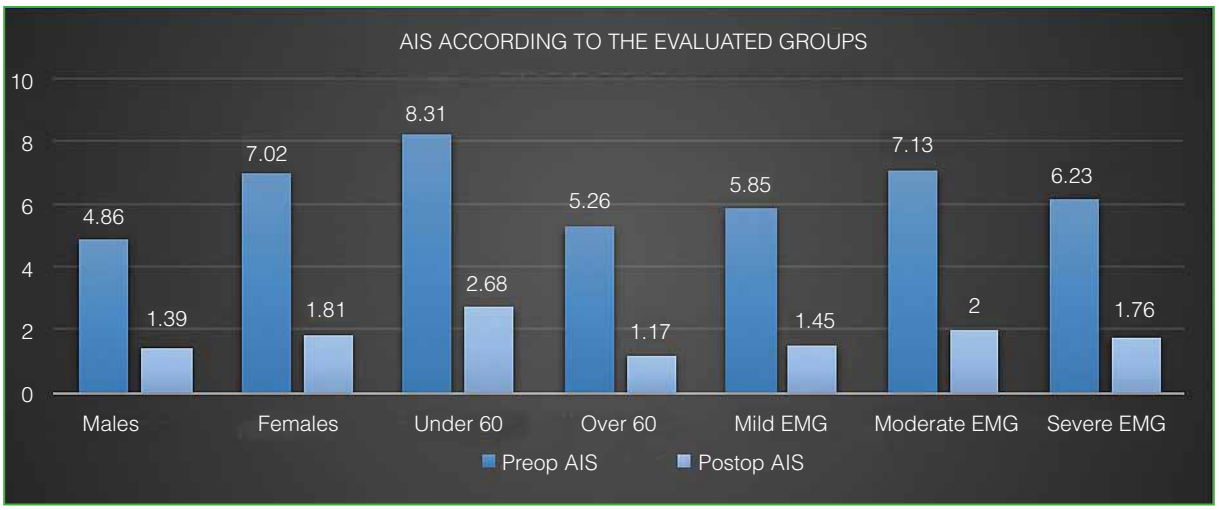

Figure 2. Results of the Athens Insomnia Scale according to the groups evaluated

Sleep disturbances are a major problem within Public Health, including a myriad of causes. The *American Academy of Sleep Medicine* divides them into dyssomnias (including insomnia), parasomnias, and sleep disturbances related to other medical conditions.[19] The latter group includes a variety of medical disorders that alter night sleep or cause daytime sleepiness. Regarding hand diseases, CTS, rheumatic symptoms, and fractures are common causes of pain and sleep disturbance.[20] It has been observed that 78% of patients diagnosed with CTS and evaluated with validated methods have sleep disturbances.[21]

The importance of detecting and characterizing insomnia is reflected in the various classification systems described. In 1995, Soldatos developed a classification (AIS) that evaluates both sleep quality, daytime well-being, and performance.[12] In 2000, it was validated within the International Classification of Diseases (ICD-10) of the World Health Organization[13], in Spanish since 2005. [14]

The results of carpal tunnel release on sleep quality have been recently evaluated using different scales and indirect methods (Table 3).

Table 3. Outcomes in the literature.

Author	n	Sleep disturbance before surgery	Evaluation method	Outcomes	
				Changes in the quality of sleep	Beginning of changes
Tulipan[22] (2017)	398	?	Quick-DASH, ISI (Pre-surgery/ 2 weeks post-surgery, 3 months post-surgery)	Significant improvement 2 weeks post-surgery ($p < 0.05$), no differences at 3 months post-surgery	2 weeks post-surgery
Rubin[23] (2017)	21	86%	ISI, Sleep Log, Actigraphy (Pre-surgery/Post-surgery?)	Significant improvement ($p < 0.0001$)	?
Erickson[24] (2019)	44	72%	PSQI (Pre-surgery / 3 months post-surgery)	Significant improvement ($p < 0.001$)	At 24 h (?)
Niedemeier[25] (2020)	40	?	Quick-DASH, PSQI, VAS (Pre-surgery / 2 weeks post-surgery /6 weeks post-surgery)	Significant improvement ($p < 0.05$)	At 24 h (?)

ISI = Insomnia Severity Index, PSQI = Pittsburgh Sleep Quality Index, VAS = Visual Analog Scale, ? = debatable or not described.

In all the studies reviewed, the improvement of sleep quality after surgery is uniform. Different assessment scales have been used, but AIS is the only one validated among them. On the other hand, postoperative controls were carried out on the second week and three months after surgery, which allowed to assess mediate improvement and changes over time. It should be noted that there were no differences between the second week and three months.

In our series, we decided to carry out the evaluation on the fourth postoperative day to reduce the information bias attributable to the passing of days, focusing on the 'immediate' improvement after surgery.

Sleep quality was statistically better after carpal tunnel release ($p < 0.05$), in each of the parameters evaluated and in all cases evaluated. No significant differences were found in the results according to age, sex, or severity of the condition.

As for the strengths of the study, we can mention that it was a prospective series with close evaluation to reduce errors in data collection, that we used a scale validated by the World Health Organization ICD-10 and in Spanish, and that we gathered a sufficient amount of cases.

Its weakness lies in not having done a more in-depth study of the comorbidities that could alter the quality of sleep (sleep apnea, diabetes, smoking, inflammatory diseases or another disorder that affects sleep). However, the significant change in the immediate postoperative period enables us to think that the effect is related to the procedure.

While not included in the design of the study, it could be inferred that improvement in sleep quality is a sign of good prognosis independent of proper carpal tunnel release, and it is an interesting line for future studies.

We can conclude that decompression of the median nerve in the carpal tunnel consistently and immediately improves the quality of sleep and daytime performance related to lack of sleep, and that this improvement is independent of sex, age, or severity of symptoms.

Therefore, this objective should be given the same importance as the others proposed when considering decompression of the carpal tunnel.

Conflict of interest: The authors declare they do not have any conflict of interest.

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