Gac Sanit. 2013;27(3):214–219

Original article

Carpal tunnel release surgery: small-area variation and impact of ambulatory surgery in the autonomous region of Valencia, Spain

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ARTICLE INFO

Article history:
Received 22 February 2012
Accepted 24 July 2012
Available online 4 December 2012

Keywords:
Carpal tunnel syndrome/surgery
Clinical practice variation
Small-area variation analysis
Public-private partnerships

ABSTRACT

Objective: This study aimed to analyze variability in rates of carpal tunnel release surgery among the healthcare areas of the autonomous region of Valencia, and to evaluate the contribution of ambulatory surgery and referrals to private hospitals to the variability found.
Methods: We carried out a cross-sectional, population-based study, describing the rates of carpal tunnel release surgery, standardized by age and sex, among areas in the region of Valencia in 2006. The observed variation was then analyzed using small-area analysis methods. Data from hospital admissions, referrals to private hospitals, population statistics and hospital resources were used to construct standardized rates, and Spearman's correlation was used to test the association with surgical setting and hospital resources.
Results: There were 8.2 carpal tunnel release surgeries per 10,000 inhabitants in the region of Valencia in 2006. Most (88.2%) of these interventions were performed as ambulatory surgery. After we excluded areas outside the 5th-95th percentiles, variation among areas was moderate and was similar for men and women. Variation was not associated with the proportion of the distinct surgical settings (admission to a public hospital, outpatient clinic, or referral to a private hospital) used in each area, or with the availability of resources.
Conclusions: Variation in carpal tunnel release surgery among areas in the region of Valencia is moderate, but has a strong impact on the population because of the high prevalence of this disorder. This variation is not explained by the hospital resources available in each area or the surgical setting.

Cirugía de liberación del túnel carpiano: variabilidad e impacto de la cirugía ambulatoria en la Comunidad Valenciana

Palabras clave:
Síndrome del túnel carpiano/cirugía
Variabilidad en la práctica médica
Análisis de áreas pequeñas
Colaboración público-privada

RESUMEN

Objetivo: Analizar la variabilidad en las tasas de cirugía de liberación del túnel carpiano entre las áreas de salud de la Comunidad Valenciana y evaluar la contribución de la cirugía ambulatoria y las derivaciones a esta variabilidad.
Métodos: Estudio transversal, ecológico, descriptivo de la variabilidad en las tasas de liberación del túnel carpiano estandarizadas por edad y sexo entre las áreas de salud de la Comunidad Valenciana en 2006. Para construir las tasas se combinó información de ingresos hospitalarios, derivaciones a centros concertados y estadísticas poblacionales, y se utilizó el coeficiente de correlación de Spearman para valorar la asociación entre las tasas obtenidas, la proporción de cada modalidad quirúrgica y los recursos hospitalarios.
Resultados: Se realizaron 8,2 intervenciones de liberación del túnel carpiano por 10.000 habitantes, en su mayor parte ambulatoriamente (88,2%). Tras excluir las áreas por fuera de los percentiles 5-95, la variación entre territorios fue moderada, similar para hombres y mujeres, y no se asoció a la proporción de las diferentes modalidades quirúrgicas (con hospitalización, ambulatoria o derivación a centros privados) ni a la disponibilidad de recursos hospitalarios.
Conclusiones: La variabilidad de la cirugía de liberación del túnel carpiano es moderada, pero tiene un importante impacto poblacional por su alta prevalencia. La disponibilidad de recursos hospitalarios y la modalidad quirúrgica no parecen influir en la variabilidad entre territorios.

Introduction

Carpal tunnel syndrome (CTS) is the most frequent nerve-entrapment syndrome and a relevant population disabling

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http://dx.doi.org/10.1016/j.gaceta.2012.07.008

condition. CTS is most common in women, with an incidence peak in the 50–59 year age group in contrast to a gradually increasing age-related trend in men.[1–3] Atroshi et al. reported that the prevalence of "clinically certain" CTS among the Swedish general population from 25 to 74 years old was 3.8% (men: 2.8%; women: 4.6%).[4] Other studies report different figures according to distinct diagnostic criteria and different population groups, countries and study year.[5–7] Incidence studies also show very different figures,[8] from 10[9] to 40[10] new cases per 10,000 person-years. Nonetheless, incidence studies generally show an increasing temporal trend.[2,3,8,10–12]

In accordance with this high prevalence, the population incidence of carpal tunnel release (CTR) surgery shows figures between 6-7 interventions per 10,000 person-years in European countries[13–17] and two-three times higher in Canada and the United States.[18–20] Surprisingly, the study of medical practice variations in CTR has stirred up little interest. Only a few papers have examined this topic: a first study in Maine reported CTR incidence rates from 8.2 to 28.7 interventions per 10,000 inhabitants in 21 hospital referral areas in 1993[19]; Mattioli et al. reported rates -always per 10,000 and year- from 5.0 to 13.2 in 7 Italian regions from 1997-2002,[1] and Tepper et al., in Canada, report rates between 8.3 and 19.5 in 4 rural/urban settings.[20] In Spain, one report in seven areas in Catalonia described CTR rates between 7.6 and 17.2 in 2000,[16] and the Spanish Atlas on Medical Practice Variation project showed rates from 0.2 to 13.9 per 10,000 in 105 healthcare areas from 11 regions in 2002 (from 13.1 to 76.2 in people of 65 years and older),[17] although the authors note these estimates could be imprecise because part of the CTR surgery was performed in the outpatient setting or referred to private hospitals, making utilization data difficult to obtain.

Ambulatory surgery and referral to private hospitals are largely used in Spain to improve efficiency and reduce elective surgery waiting lists, but it is not clear if these strategies contribute to decreasing small-area variations (it would suggest that areas with less resources use these policies to enhance their population surgery rates) or, on the contrary, to increasing differences (suggesting that areas with higher surgery rates apply these policies in a more intensive way than their counterparts with lower rates). The objectives of this study are to describe CTR surgery rates in the Valencia region, to analyze variability among their 22 healthcare areas and to evaluate the contribution of ambulatory surgery and referrals to private hospitals to the variability found. We begin from the null hypothesis of the absence of systematic variation between healthcare areas and the absence of association between surgery rates and the percentage of ambulatory surgery or referrals.

Methods

Design

Cross-sectional population-based study, descriptive of the 2006 CTR surgery age-sex standardized rates among areas in the autonomous region of Valencia (Spain), followed by analysis of the observed variation using small area variation analysis methods.

Population/setting

The unit of analysis in our study was the 22 healthcare areas managed in 2006 by the Valencia Healthcare Agency, the regional public health service in the Valencia Autonomous Community, a Spanish region with 5 million inhabitants. Spain is divided into 17 autonomous regions -known as "Autonomous Communities"- with a high degree of self-government which includes responsibility for health care. Each Spanish regional government operates an extended hospital and primary healthcare centre network, which in 2006 provided free care (financed by public taxes) for about 97% of their respective populations. These regional networks are organized into healthcare areas with one acute public hospital serving the resident population (around 150,000 to 250,000 inhabitants) in a delimited geographical territory.[21]

Main endpoint

The main endpoint of the study was the CTR surgery age-sex standardized rates. The residents of each area define the denominator of the rates, while the residents undergoing CTR surgery define the numerator. Surgical interventions were accounted for in the area of patient's residence, whether they were carried out in public or private hospitals inside or outside that area. The International Classification of Diseases 9th revision of Clinical Modification codes (ICD9CM) code 04.43 was used to select CTR surgeries, and specific residency codes (or municipal codes if the residency code was absent) were used to assign every patient to the healthcare area in which they live. Admissions of residents outside other countries or other Spanish autonomous communities were excluded.

Other variables

Other variables used in the study included:

1) Proportion of use of surgical schemes: inpatient and outpatient CTR surgery in public hospital, and CTS referred to private hospitals for surgery. All CTR in private hospitals was performed as outpatient surgery.
2) Operating theatres in public hospitals per 100,000 residents in the healthcare area.
3) Orthopaedic public hospital beds per 1,000 inhabitants of the respective area.
4) Full-time equivalent orthopaedic surgeons in the public healthcare network per 1,000 inhabitants of the respective area.
5) Length-of-stay (LOS) of the patients in orthopaedic wards in each hospital.
6) Bed occupancy in orthopaedic wards in each hospital.

Data sources

Data on patients undergoing inpatient or outpatient surgery in public hospitals came from the Hospital Discharge Administrative Databases in 2006 (calendar year) of the Atlas of Variations in Medical Practice in the Spanish National Health System project,[22] a research project that emulates the Dartmouth Atlas of Health Care[23,24] and aims to inform Spanish decision-makers on differences in such parameters as hospital admissions or surgery for specific conditions across geographical areas. These administrative databases, produced by every acute care hospital in the Spanish National Health System, provide the following information for every single admission: age, sex, admission and discharge dates, diagnosis and procedure codes according to the International Classification of Diseases 9th revision Clinical Modification codes (ICD9CM), and residence codes identifying the patient's area of residence. Data on patients undergoing surgery in private hospitals were facilitated by the Valencia Healthcare Agency. Denominators to calculate population rates came from the Municipal Register of Inhabitants of the Spanish National Institute of Statistics for 2006. Data on healthcare resources came from the Spanish Ministry of Health 2006 Statistics of Healthcare Centres with Inpatient Facilities.[25,26]

Extremal quotient (EQ)	$EQ = \frac{\max(DSR_i)}{\min(SDSR_i)}$
Coefficient of variation (CV)	$CV = \frac{\sqrt{\sum(DSR_i - \overline{DSR})^2/(I-1)}}{\sum DSR_i/I}$,with $\overline{SSR} = \frac{\sum DSR_i}{I}$
Weighted coefficient of variation (CVw)	$CV_W = \frac{\sqrt{\sum n_i (DSR_i - \overline{DSR})^2/(\sum n_i - 1)}}{\sum n_i DSR_i / \sum n_i}$
Systematic component of variance (SCV)	$SCV = \frac{1}{I}\left(\sum \frac{(y_i - e_i)^2}{e_i^2} - \sum \frac{1}{e_i}\right)$
Empirical Bayes (EB)	EB : Empirical – Bayes estimate of σ^2 assuming $\log r_i \approx N(0,\sigma^2)$, being r_i the relative risk
DSR: standardized rate; SSR: standardized surgery ratio.	

Figure 1. Formulation of the descriptive statistics.

Ethics

The study, observational in design and with retrospective data anonymized prior to their transfer to the researchers, did not require Ethics Committee approval.

Analysis

First, we calculated the standardized age-sex rates (direct method) using the 2001 Spanish census population as the reference population. Second, we estimated the indirect standardized surgery ratio (SSR), the quotient of the observed (y_i) to the expected (e_i) number of surgery cases, and represented these ratios in healthcare area maps. The expected cases of CTR were derived based on the age-specific rate for 18 five-yearly age groups and the sex stratum in the standard population, which was the population from the 22 healthcare areas under study. More precisely, $e_i = \sum_{j,k} n_{ijk} R_{jk}$, where n_{ijk} is the population in area i, age group j and sex stratum k, and R_{jk} is the age-sex specific rate for the whole region under study. Because SSR are very dependent on the number of residents in each area, and the variability of observed cases is usually higher than the expected variability in a Poisson distribution (extravariability) we used the spatial smoother method proposed by Besag, York and Mollié (BYM model) [27,28] to smooth the SSR, reduce the extravariation and allow us to visualize subjacent patterns.

To assess variability we use the common statistics of small area variation analysis[29]: extremal quotient (EQ), coefficient of variation (CV), weighted coefficient of variation (CVw), systematic component of variation (SCV), and empirical Bayes (EB) variance component. Because the presence of areas with extreme values, and as in the Spanish Atlas of variation[22], we calculated some statistics excluding areas outside the percentiles 5-95 and denoted them as EQ5-95, CV5-95; CVw5-95 and SCV5-95. Figure 1 shows the formulation of statistics. Here DSR_i refers to the direct standardized rate per 10,000 inhabitants at the i-th health area, with $i = 1,\ldots,I$, while y_i and e_i are the observed and expected cases respectively. Finally, we used the Spearman's correlation coefficient to analyze the bivariate associations between the standardized surgery rates and the proportion of surgical schemes used (inpatient, outpatient and private referral) and resource variables in each area (described in the Table 1). All analyses were carried out using STATA® 9 (StataCorp, College Station, Texas) and R (RDC Team. 2004. http://www.R-project.org) except from the SSR smoother, which was carried out with WinBUGS 1.4.

Results

The Valencia Healthcare Agency performed 4,126 CTR surgeries in 2006 (8.18 per 10,000 inhabitants); 2,861 interventions were carried out in public hospitals, 487 (11.8%) with conventional hospital admissions and 2,374 (57.5%) as ambulatory surgery, and 1,265 (30.7%) were referred and carried out in private hospitals, all as ambulatory surgery. Rates of surgery (Table 2 and Fig. 2) ranged from 1.13 to 12.76 per 10,000 inhabitants between areas in the 5 and 95 percentiles. Small area variation statistics, excluded areas outside percentiles 5 and 95, showed a moderate degree of variability, with 2.7 times more interventions between extreme areas.

Table 1
Resource and performance indicators in the Valencia Health Agency orthopaedic wards (2006).

	Surgery rooms 100,000 inhab.	Orthopaedic beds per 1,000 inhab.	Orthopaedic surgeons per 1,000 inhab.	Length of stay in orthopaedic wards	Bed occupancy in orthopaedic wards (%)
Min	2.37	0.53	0.43	3.96	48.84
Max	10.83	3.74	1.46	7.48	103.08
Percentile 5	2.75	0.94	0.44	4.14	55.37
Percentile 25	3.49	1.11	0.58	5.00	65.86
Percentile 50	4.54	1.58	0.66	6.16	71.88
Percentile 75	6.21	1.98	0.86	7.13	78.01
Percentile 95	9.40	3.45	1.37	7.33	93.13
Extrem. quotient	4.57	7.06	3.40	1.89	2.11
$Quotient_{5\text{-}95}$	3.42	3.67	3.11	1.77	1.68
$Quotient_{25\text{-}75}$	1.78	1.78	1.48	1.3	1.18
Coeff. variation	0.42	0.48	0.36	0.19	0.17

Source: Spanish Ministry of Health 2006 Statistics of Healthcare Centres with Inpatient Facilities.[25,26]

Table 2
Carpal tunnel release surgery (Valencia Community, Spain, 2006). Standardized rates and variation statistics.

	Men	Women	All
Crude data			
Inhabitants	2,434,221	2,510,673	5,040,489
CTR surgery	834	3,292	4,126
Crude rate	3.43	13.11	8.18
Age-sex Standardized			
Min	0.36	0.18	0.32
Max	7.99	24.73	12.76
Rates			
Percentile 5	0.46	1.89	1.13
Percentile 25	2.50	9.25	5.66
Percentile 50	3.27	12.42	8.21
Percentile 75	3.99	16.44	9.77
Percentile 95	6.18	20.52	12.76
Variation Statistics			
Extremal quotient	22,19	137,39	39,88
$Quotient_{5-95}$	2.64	2.69	2.71
$Quotient_{25-75}$	1.54	1.48	1.31
Coefficient of variation	0.50	0.46	0.46
Coefficient of $variation_{5-95}$	0.28	0.28	0.27
Weighted coefficient of variation	0.48	0.41	0.41
Weighted coefficient of $variation_{5-95}$	0.30	0.30	0.29
Systematic component of variation	0.22	0.20	0.20
Systematic component of $variation_{5-95}$	0.04	0.07	0.07
Empirical Bayes	0.26	0.47	0.47

N = 22 areas (inhab). All rates per 10,000 residents. The subindex indicates the corresponding statistic has been estimated with the observations included in the specified percentiles.

Surgery rates were higher in women (13.1/10,000 woman/year vs. 3.4 in men), but the statistics of variability were similar.

Figure 3 shows the geographical distribution of the standardized surgery rates. Several territories, including the city of Valencia, showed non-significant differences with the Autonomous region in global terms, but some areas on the north and on the south coast had lower rates than average, and the central areas had higher rates. By sex, men and women showed similar territorial patterns, but the lower surgery rate in men produces more non-significant

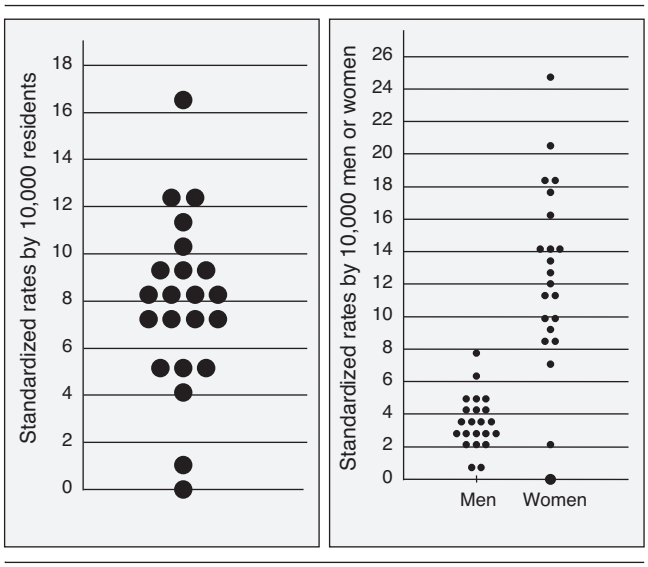

Figure 2. Standardized rates of carpal tunnel release surgery (Valencia Community, Spain, 2006).

areas. Rates in men and women by areas exhibit a strong correlation ($r = 0.84$; $r^2 = 0.72$; $p < 0.001$). Table 3 shows the bivariate correlations between CTR surgery rates and the proportion of surgical practices and resources used. None of the variables analyzed was associated with surgery rates.

Discusion

Results of this study show a rate of 8.2 CTR surgeries per 10,000 inhabitants in the Valencia Region, performed in the most part as ambulatory surgery (88.2%). Excluding areas outside 5-95 percentiles variation was moderate (RV5-95 = 2.7, slightly higher than that observed in the hip fracture hospitalization, the condition commonly used as a pattern of low variability),[17] similar for women and

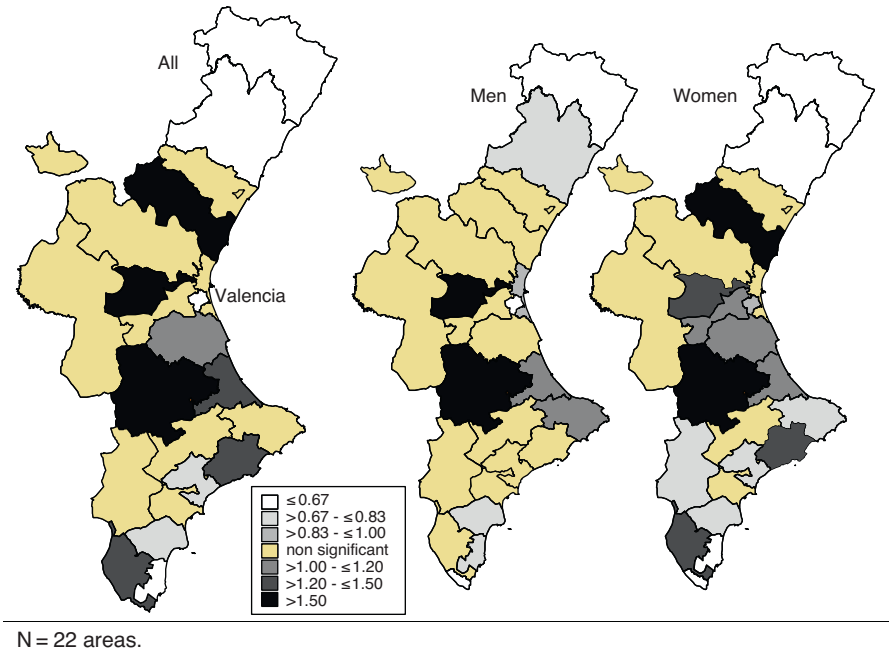

Figure 3. Standardized surgery ratios of carpal tunnel release surgery by areas (Valencia Community, Spain, 2006).

Table 3
Bivariate Spearman's correlations between surgical practices and resources variables with rates of CTR surgery.

	r	p
Surgical schemes		
Percentage of inpatient surgery	-0,38	0,078
Percentage of ambulatory surgery	-0,01	0,990
Percentage of referrals to private hospitals	-0,04	0,851
Percentage of ambulatory surgery and referrals	0,38	0,078
Resources		
Surgery rooms 100,000 inhabitants	0,20	0,366
Orthopaedic beds per 1,000 inhabitants	0,02	0,934
Orthopaedic surgeons per 1,000 inhabitants	0,20	0,379
Productivity		
Length of stay in orthopaedic wards	-0,19	0,399
Percentage of bed occupancy in orthopaedic wards	0,19	0,390

N = 22 areas; CTR: carpal tunnel release.

men, and was not associated with the proportion between surgical schemes used in each area, or with the availability of resources.

The CTR surgery rate was higher than that reported in previous studies in the Valencia Region (1.1/10,000 inhabitants for 1995-1996[30] and 5.7/10,000 for 2002[17]), although those studies did not include referrals to the private sector. On the contrary, the CTR surgery rate was lower than that described for Catalonia in 2000.[16] These data suggest that CTR surgery rates could have been increasing in Spain in recent years and, also suggest a substantial variability between regions, as reported in the Atlas of Medical Practice Variation project.[17] Regarding the role of ambulatory surgery, this surgical scheme seems clearly consolidated for CTR in the Valencia region (4 in 5 CTR surgeries are performed on ambulatory basis). Lower proportion of ambulatory surgery in public hospitals is probably related to the retention of patients with more complex conditions or with more comorbidity, although it is also possible that public hospitals could increase their proportion of outpatient surgery. The higher rate of surgery in women is consistent with their higher prevalence of CT Syndrome.

Regarding variation, the range found was similar to that described for areas in Catalonia in 1995-2000[16] or in Maine at the start of the 1990s,[19] but lower than in other studies,[22,30] although the variability found in these last studies seems due to the presence of territories with extreme rates and variation statistics would have been similar to the rest of the studies if areas outside the 5-95 percentiles had been excluded. Nonetheless, this moderate variation has relevant repercussions at the population level. For example, the Valencia region would perform 2,306 more CRT surgeries if the rate of the area in the 95 percentile were adopted as the region average rate (and the costs of this increase in surgery rates could be higher than the savings generated by the transfer of all CTR interventions to the ambulatory setting). Nevertheless, regional healthcare services in Spain maintain a substantial waiting list for CTR surgery (about 2.3 people per 10,000 inhabitants in 2006)[31] and lowering rates could also have a relevant impact on waiting times.

Although the population resident in each area is the object of different surgical intensity, these differences do not seem to be associated with the avalaibility of orthopedic resources in each departament, nor with the proportion of surgical practices, including referral to private hospitals. The hypothesis that ambulatory surgery increases the rates of surgery has been presented occasionally.[32] Our results suggest that higher rates in CTR surgery are not related to higher use of ambulatory surgery or more referrals to the private sector.

This study has several limitations. First, the ecological design affects the causality of the observed relations and the transfer to the individual level. Second, the variation between centres can be affected by the completeness and quality of registers, although CTR is a common intervention and is usually well registered by the Hospital Admission and Documentation services. Third, the data used corresponds to the year 2006, the only one for which we have information on the concerted activity. Since then there have been several changes in the Valencia Health Agency (opening of new hospitals, extension of private concessions, management contracts with indicators of productivity and incentives, etc.) that could modify the results found. Fourth, surgery rates in some areas could be theoretically affected by the degree of attention to non-residents (people living in other communities or other countries) excluded from the study, although the small number of exclusions (less than 1% of the admissions for all causes) makes it unlikely that this effect may have had a major impact on surgery rates. Finally, and more relevant, the hypothesis that ambulatory surgery increases surgery rates requires a longitudinal design and the findings of this cross-sectional study, although suggestive, should not be considered as definitive. This hypothesis has never been formally evaluated and, although it is not supported by our results, other data suggest technological or organizational changes could increase surgery rates in areas with different basal rates. For example, CTR surgery in Catalonia[16] increased from 7.6 to 13.2 per 10,000 persons/year between 1996 and 2000, whereas the area with a lower basal rate increased from 5.0 to 7.6, the area with a higher basal rate increased from 11.1 to 15.1, suggesting that increments in surgical rates were rarely used to reach any convergence between territories with possible under and overutilization. In fact, territories with higher rates increased at the same rhythm as those of other territories, sustaining the variability among them.

Medical practice variation studies do not permit us to determine what rate is right,[33] but highlights that healthcare services manage very similar populations in very dissimilar ways, and at least raise the question of whether some populations are under or overtreated, with the subsequent problems of quality losses and waste of scarce resources. There is evidence of the effectiveness of CTR surgery in clinical improvement and other endpoints, but the severity threshold to decide between surgery and conservative management remains uncertain.[34] Clinical trials in patients with mild symptoms can be useful to clarify these aspects, but the use of functional measures or health-related quality of life instruments could also be interesting to objectify the severity threshold currently used in each territory and to inform practice policies, whether to increase (if in some areas patients suffer unacceptable pain or functional loss conditions) or decrease (if in some areas surgery is performed in mild or inappropriate cases) surgery rates.

Authors' contributions

P. Rodríguez-Martínez, S. Peiró and M. Gisbert-Grifo conceived the idea, did the data analyses, performed the literature search and wrote the first draft of the manuscript. J. Calabuig-Pérez performed the data extraction. J. Librero, E. Bernal-Delgado, M. Ridao-López, J. Calabuig-Pérez and G. Sanfélix-Gimeno participated in conceiving the study design, prepared the databases, data analyses and interpretation of the data. All authors have been involved in discussed analyses, interpretation, and presentation. All authors have contributed to, seen and approved the final submitted version of the manuscript.

Funding

This study is part of the Atlas of Medical Practice Variation in the Spanish National Health System research project, funded by

What is known on the topic?

Carpal tunnel syndrome is the most frequent nerve-entrapment syndrome and a relevant population disabling condition and carpal tunel release surgery is highly prevalent. However, medical practice variations in carpal tunel release surgery have been little studied. Ambulatory surgery and referral to private hospitals are largely used in Spain to improve efficiency and/or reduce elective surgery waiting lists, but it is not clear if these strategies contribute to decreasing or increasing variations in surgery between populations in different geographical areas.

What does this study contribute to the literature?

The Valencia Healthcare Agency performed 4,126 carpal tunel release surgeries in 2006 (8.18 per 10,000 inhabitants), significantly higher in women than in men, and performed in the most part as ambulatory surgery (88.2%). Excluding areas outside 5-95 percentiles variation was moderate, similar for women and men, and was not associated with the proportion between surgical practices used in each area, or with the availability of hospital resources. Our results suggest that higher population rates in carpal tunnel release surgery rates are not related to higher use of ambulatory surgery or more referrals to the private sector.

the *Instituto de Salud Carlos III* at the Spanish Ministry of Health (PI06/1673, PI05/2490, G03/202), the *Obra Social y Cultural de Ibercaja*, and the *Fundación Instituto de Investigación en Servicios de Salud*.

Conflict of interests

None.

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