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ORIGINAL ARTICLE

Symptoms During or Shortly After Isolated Carpal Tunnel Release and Problems Within 24 hours After Surgery

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Abstract This study used the National Survey of Ambulatory Surgery (NSAS) database to measure the incidence of and risk factors for symptoms in the ambulatory surgery center and problems within 24 h after isolated carpal tunnel release (CTR). The NSAS contained records on 400,000 adult patients with carpal tunnel syndrome who were treated with CTR in 2006, based on ICD-9 codes. The type of anesthesia used and factors associated with symptoms and problems were sought in bivariate and multivariable statistical analyses. The mean duration of the procedure was 16±8.8 min. Only 5 % were performed under local anesthesia without sedation, 45 % with IV sedation, 28 % regional anesthesia, and 19 % general anesthesia. Symptoms in the ambulatory surgery center or a problem within 24 h after discharge were recorded in 10 % of patients, all of them minor and transient, including difficulties with pain and its treatment. The strongest risk factors were male sex, age of 45 years and older, and participation of an anesthesiologist. Local anesthesia and regional anesthesia were associated with more perioperative symptoms and postoperative problems. Most CTR are performed with some sedation in the United States. CTR is a safe procedure: one in 10 patients will experience a minor issue in the perioperative or immediate postoperative period.

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Introduction

Carpal tunnel syndrome (CTS) is one of the most common hand surgical diseases and definitive treatment consists of carpal tunnel release (CTR). It is the most common hand surgical procedure in the National Survey of Ambulatory Surgery (NSAS) [1]. This procedure is performed annually in an outpatient setting between 300,000 to 600,000 times in the United States with increasing incidence over the past 10 years [2, 3]. Although this is the most commonly performed hand surgical procedure, adverse events or problems after discharge are common. They were encountered in 1 to 25 % of all CTR [4–11], although these studies were focusing mainly on surgical complications.

In general, perioperative ambulatory procedural data has been less extensively analyzed than inpatient data [12]. Some studies assessed perioperative pain with or without a relationship to the type of either surgery or anesthesia care, however these studies predominantly included wide-ranging ambulatory procedure groups and were not limited to hand surgical patients [13, 14]. Pain was the most frequently reported problem after ambulatory procedures in general. It was present in up to 40 % of patients even after 1 week, but steadily decreased after the first postoperative day [13, 14]. The desired positive influence of non-steroidal anti-inflammatory drugs, local anesthetics injected into the wound at the end of the procedure, or propofol on pain have also been analyzed [15, 16]. Little is known about perioperative symptoms within ambulatory care centers, problems within 24 h of surgery, or the risk factors for these symptoms and problems in hand surgical patients.

The purpose of this study was to use a large database of ambulatory surgical care patients (NSAS) that had isolated CTR for CTS to determine the incidence of and risk factors for symptoms and problems during or within 24 h after surgery. The NSAS has been used in the past to analyze incidences and trends in ambulatory surgical and anesthesia care [1, 17]. We specifically hypothesized that age, sex, and the use of an anesthetic technique other than local anesthesia would be predictive of symptoms during or after surgery, including problems after discharge.

Material and Methods

NSAS and Study Design

The publicly accessible NSAS database served as a data source for this retrospective study [18, 19]. Our institutional review board (IRB) confirmed this study to be exempt from IRB approval. The NSAS was initiated by the National Center for Health Statistics to periodically collect information about surgical and nonsurgical procedures performed on a scheduled ambulatory basis (admitted and discharged on the same day or subsequently admitted to a hospital as an inpatient) in hospitals and freestanding ambulatory surgery centers in the United States. The surveys were conducted in 1994 to 1996 and 2006. The NSAS presented nationally representative estimates, corresponding weighted numbers of surveyed patients. The estimates were calculated via a multi-stage probability design, based among others on the number of civilians in the United States for the surveyed years. Information collected from records included sex, age, diagnosis and procedures based on the codes of the International Classification of Diseases, 9th Revision, Clinical Modification, length of surgery, length of time in operating room (OR), length of time in the post-operative care unit (PACU) until discharge home, type of anesthesia (local, intravenous (IV) sedation or monitored anesthesia care (MAC), regional, general), anesthesia provider (anesthesiologist and/or certified registered nurse anesthetist (CRNA), or surgeon; more than one provider may have been involved), symptoms during or after surgery and problems after discharge. According to the NSAS, symptoms during or after surgery included airway obstruction, bleeding, difficulty waking up, hypoxia, hypotension, hypertension, nausea, vomiting, pain and other events; problems encountered within 24 h after discharge included: calling the doctor or the ambulatory surgery center or going to the Emergency Department. The present data allowed only dichotomous responses (yes or no) indicating that one of these symptoms or problems had occurred.

Patients

We identified all adult patients (18 years and older) who underwent isolated CTR in the NSAS database in 2006. We used an algorithm containing the corresponding primary procedural ICD-codes for CTR (04.43) as well as the primary diagnosis code for CTS (354.0). We identified 403,578 of a total estimated 57 million surgical and nonsurgical procedures performed during nearly 35 million ambulatory visits in 2006 [19].

Statistical Analysis

The dependent variables were the presence of symptoms and problems. The independent variables were sex, age, length of surgery, length of time in OR, length of time in PACU, type of anesthesia, and anesthesia provider. To further identify the impact of age, age was stratified into three empiric groups: 18 to 44 years, 45 to 64 years, 65 and older. The type of anesthesia was divided into four groups (while patients may have gotten more than one type of anesthesia we focused on the highest order of anesthesia only: local<IV sedation / MAC<regional or block<general); anesthesiologists and CRNA were combined in the same group based on a recently published NSAS anesthesia study which explained that survey respondents were not exactly instructed on how to differentiate between CRNA alone and CRNA medically guided by an anesthesiologist [20]. Continuous data were presented as mean±standard deviation (±SD), and unpaired t-tests were performed to determine the differences between continuous variables. Categorical data were reported in absolute numbers and percentages. Pearson's Chi-square tests were used to analyze differences between two categorical variables. Due to the large sample size, only variables with $p<0.001$ were next entered into the multivariate analysis (stepwise backward logistic regression). We subsequently analyzed symptoms in the ambulatory surgery center and problems within 24 h after discharge separately.

Results

The cohort comprised 69 % women and 31 % men with a mean age of 55±16 years (Table 1). The mean duration of the procedure was 16±8.8 min. Patients operated under local anesthesia alone left the surgery center an average of 24±12 min after surgery compared to 55±45 min in patients treated with another anesthetic technique ($p<0.001$). An anesthesiologist and/or CRNA was involved in 89 % of the procedures. Only 5 % were performed under local anesthesia without sedation, 45 % with IV sedation, 28 % regional anesthesia, and 19 % general anesthesia; the older the patients

Table 1 Bivariate analysis of carpal tunnel syndrome patients treated with carpal tunnel release‡ n=403578

		Total		Symptoms in the ambulatory surgery center		Problems after discharge	
		N	%	N	%	N	%
Sex	Male	126548	31 %	6047	4.8 %	15277	12 %
	Female	277030	69 %			12451	4.5 %
Age (Years±SD)		55±16		59±13		54±11	
Age categories	18-44	100804	25 %	2323	2.3 %	5298	5.3 %
	45-64	194741	48 %	5227	2.7 %	20680	11 %
	65 & up	108033	27 %	8127	7.5 %	1750	1.6 %
Length of surgery*		16±8.8		17±8.3		17±9.9	
Length of time in OR*		38±14		35±9.5		34±9.5	
Length of time post-op*		55±47		91±53		53±45	
Anesthesia: Local		19592	4.9 %	593	3.0 %	452	2.3 %
Anesthesia: IV sedation / MAC		182371	45 %	9021	4.9 %	14944	8.2 %
Anesthesia: Regional		112035	28 %	3904	3.5 %	8231	7.3 %
Anesthesia: General		74936	19 %	2159	2.9 %	2683	3.6 %
Anesthesia: Not specified		14698	3.6 %	0	0 %	1418	9.6 %
Anesthesia by: Anesthesiologist and/or CRNA		360436	89 %	15064	4.2 %	26646	7.4 %
Anesthesia by: Surgeon		31298	7.8 %	302	1.0 %	1082	3.5 %
Anesthesia by: Not specified		11844	2.9 %	311	1.0 %	0	0.0 %
Symptoms in the ambulatory surgery center		15677	3.9 %			2408	15 %
Problems after discharge		27728	6.9 %				

‡All bivariate analyses were $p<0.001$

*in minutes

CRNA certified registered nurse anesthetist; *IV* intravenous; *MAC* monitored anesthesia care; *OR* operating room; *SD* standard deviation

got the more they had local and the younger the more general anesthesia (Table 2). Symptoms in the ambulatory surgery center or a problem within 24 h after discharge was recorded in 10 % of patients, with 0.6 % experiencing both.

Symptoms in the Ambulatory Surgery Center

Symptoms in the ambulatory surgery center were recorded in 3.9 % of patients. Most symptoms were minor, including accidental laceration / puncture, bleeding, transient hypotension or hypertension, and issues related to pain and its treatment such as nausea and vomiting. No apnea, airway obstruction, fainting, dysrhythmia or cardiac arrests were encountered. Patients suffering symptoms left the surgery center an average of 91±53 min after surgery compared to 52±44 min in patients without symptoms ($p<0.001$). Male sex, age of 45 years and older, length of surgery, length of time in the postoperative care unit, regional anesthesia, IV sedation / monitored anesthesia care, local anesthesia and anesthesia by the anesthesiologist and/or CRNA were associated with symptoms in the ambulatory surgery center. Shorter time in the OR was associated with fewer adverse events (R square=0.15, fair accuracy with an area under the ROC curve=0.77) (Table 3).

Problems After Discharge

A problem after discharge was recorded in 6.9 % of patients. Problems included calling the doctor or the ambulatory surgery center, returning to the ambulatory surgery center, or other issues mostly related to pain. No patients went to an emergency department or were admitted to a hospital. Factors associated with a documented problem after discharge included male sex, age of 45 years and older, length of time in the OR, local anesthesia, regional anesthesia, and anesthesia by the anesthesiologist and/or CRNA (R-squared=0.082, fair accuracy with an area under the ROC curve=0.72) (Table 4). When a symptom in the surgery center was used as an explanatory variable, it was retained in the model (R square= 0.11, fair accuracy with an area under the ROC curve=0.73) (Table 4).

Discussion

Ten percent of patients in the NSAS database had a recorded symptom in the ambulatory surgery center (3.9 %) or a problem within 24 h of discharge (6.9 %) with 0.6 % of patients

Table 2 Overview anesthesia

			Sex				Age (Years ±SD)	Age categories					
	Total		Male		Female			18-44		45-64		65 & up	
	n	%	n	%	n	%		n	%	n	%	n	%
Anesthesia: Local	19592	5 %	6848	5.4 %	12744	4.6 %	61±15	2844	2.8 %	9153	4.7 %	7595	7.0 %
Anesthesia: IV sedation / MAC	182371	45 %	63619	50 %	118698	43 %	57±16	40942	41 %	78726	40 %	62649	58 %
Anesthesia: Regional	112035	28 %	32608	26 %	79427	29 %	55±14	29811	30 %	57692	30 %	24532	23 %
Anesthesia: General	74936	19 %	19507	15 %	55429	20 %	52±15	24466	24 %	41073	21 %	9397	8.7 %
Anesthesia: Not specified	14698	4 %	3966	3.1 %	10732	3.9 %	59±14	2741	2.7 %	8097	4.2 %	3860	3.6 %
Anesthesia by: Anesthesiologist and/or CRNA	360436	89 %	104382	83 %	256054	92 %	56±16	91151	90 %	174906	90 %	94379	87 %
Anesthesia by: Surgeon	31298	8 %	16764	13 %	14534	5.2 %	57±16	6953	6.9 %	14554	7.5 %	9791	9.1 %
Anesthesia by: Not specified	11844	3 %	5402	4.3 %	6442	2.3 %	58±12	2700	2.7 %	5281	2.7 %	3863	3.6 %

CRNA certified registered nurse anesthetist; *IV* intravenous; *MAC* monitored anesthesia care; *SD* standard deviation

having both. Most problems were minor. Only 4.9 % of patients had surgery under local anesthesia alone. Local anesthesia was associated with more events in the surgery center and more post-discharge problems, perhaps related to pain [21]. The fact that involvement of an anesthesiologist and/or CRNA was associated with more perioperative and postoperative events might be related to problems associated with IV sedation, but may also reflect co-existing medical conditions in this population that led to the need for oversight by a skilled anesthesia provider. Length of surgery and time in the recovery room were both associated with symptoms in the ambulatory surgery center, and this seems logical given that more complex procedures likely require additional surgical and recovery time. Men and older patients were at risk to develop symptoms or problems within 24 h after surgery.

Our study is limited by the structure of the NSAS database and the restriction to only one year of data (2006). The NSAS

Table 3 Symptoms in the ambulatory surgery center

	Sig.	Odds ratio	95 % CI	
			Lower	Upper
Sex (Male)	$p<0.001$	1.42	1.37	1.48
Age:^				
45-64	$p<0.001$	2.04	1.93	2.16
65 & up	$p<0.001$	4.01	3.79	4.24
Length of surgery*	$p<0.001$	1.039	1.035	1.043
Length of time in OR*	$p<0.001$	0.966	0.964	0.969
Length of time post-op*	$p<0.001$	1.012	1.012	1.012
Anesthesia:‡				
Local	$p<0.001$	16	14	18
IV sedation / MAC	$p<0.001$	2.38	2.23	2.54
Regional	$p<0.001$	1.22	1.14	1.32
Anesthesia by:#				
Anesthesiologist and/or CRNA	$p<0.001$	15	13	18

^reference: group "18-44"

*in minutes

‡reference: group "General"

#reference: group "Surgeon"

CRNA certified registered nurse anesthetist; *IV* intravenous; *MAC* monitored anesthesia care

Table 4 Problems after discharge

	Sig.	Odds ratio	95 % CI	
			Lower	Upper
Sex (Male)	$p<0.001$	1.83	1.73	1.93
Age:^				
45-64	$p<0.001$	1.75	1.67	1.83
65 & up	$p<0.001$	5.98	5.51	6.49
Length of surgery*	$p<0.001$	0.975	0.972	0.978
Length of time in OR*	$p<0.001$	1.010	1.007	1.013
Length of time post-op*	$p<0.001$	0.995	0.995	0.996
Anesthesia:‡				
Local	$p<0.001$	1.42	1.24	1.62
IV sedation / MAC	$p<0.001$	0.78	0.74	0.83
Regional	$p<0.001$	2.32	0.47	0.52
Anesthesia by:#				
Anesthesiologist and/or CRNA	$p<0.001$	3.21	2.94	3.50
Symptoms during or after surgery	$p<0.001$	3.15	2.99	3.33

^reference: group "18–44"

*in minutes

‡reference: group "General"

#reference: group "Surgeon"

CRNA certified registered nurse anesthetist; *IV* intravenous; *MAC* monitored anesthesia care; *OR* operating room

has limitations such as trained nonmedical personnel interpreting the medical data and incomplete information [17, 18]. For instance, about 15 % of entries had no recorded time of surgery, time in the OR, and time in the PACU. The study is also limited by providing no access to medical records of the patients, which would include associated comorbidities, history of drug dependence, pain medications administered for CTR as well as medications that the patients were prescribed for any possible comorbidities and for adverse events or problems. In addition, the NSAS database did not provide CPT codes (which would clearly allow to distinguish endoscopic versus open CTR), surgeon (residents versus attendings; hand surgeons versus other specialists) or hospital factors (teaching versus non-teaching centers). The study could have been improved by providing a clearer and more specific description of the symptoms and problems by the NSAS, e.g. defining what type of pain or issues were encountered, rather than the current study's dichotomization of the presence or absence of any type of adverse event. Despite these limitations, which could have skewed the overall outcome, this study was able to evaluate nearly half a million patient cases from a large national database, and assess risk factors that had not been definitively analyzed. Such risk factors have the potential to improve the outcome of CTR and better inform patients who will undergo this procedure.

This study reported that men are at a greater risk than women for developing symptoms during or shortly after CTR. There has not been extensive research done previously to explore gender as a risk factor for symptoms or early problems after CTR. Earlier studies have indicated that older (hand) surgical patients may be subject to more issues due to higher rates of comorbidities that accompany aging [22, 23]. In our study older patients had significantly more symptoms in the ambulatory surgery center (which can be explained with a higher comorbidity rate).

We found that local anesthesia, IV sedation and regional anesthesia were rather associated with perioperative symptoms in the ambulatory surgery center than general anesthesia. This can be explained with more pain [21]. In addition, this is however speculative, patients after general anesthesia are better informed about the early postoperative course. Prior work suggests that local anesthesia, regional anesthesia, and general anesthesia are associated with comparable safety and patient satisfaction for CTR [24, 25]. Intravenous sedation / MAC was the most common method of anesthesia in our study, and is one of the most common methods in ambulatory surgery in general [20]. The type of anesthesia may have some influence on short-term outcomes. For example, patients treated with propofol instead of sevoflurane had significantly less postoperative pain in an ambulatory setting [16], and pain was an important factor for short-term recovery after day-surgery [15]. However, pain usually decreased after the first postoperative day [14, 13]. Long-acting local anesthesia may further improve the very early postoperative course, however one recent study showed poorer results after 12 to 24 h in contrast to short-acting agents [26].

In summary, the majority of patients undergoing CTR have some form of IV sedation, with just a minority having local anesthesia alone. Patients that have CTR under local alone have shorter stays in the recovery unit. While involvement of an anesthesiologist and/or CRNA was one of the strongest risk factors for perioperative and postoperative problems, it seems most likely that this finding reflects the greater likelihood of co-existing medical problems in those requiring skilled anesthesia care. Isolated CTR is a safe procedure: no major adverse events, such as apnea, airway obstruction, fainting, dysrhythmia or cardiac arrests, were encountered; no patients were admitted to an ED or a hospital after discharge. Better perioperative patient coaching regarding pain and possible symptoms might decrease perioperative adverse events and post-discharge problems.

Ethical Standars

All named authors hereby declare that they have no conflicts of interest to disclose related to this study. And the authors adhere to the ethical standards described by the Committee on Publication Ethics and the International Committee of Medical Journal Editors. Our IRB confirmed this study to be exempt from IRB approval.

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