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Benign upper extremity tumors: factors associated with operative treatment

Heleen C. E. Sluijmer · Stéphanie J. E Becker · David C. Ring

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Abstract
Background Tumors are common in the upper extremity and are mostly benign and inconsequential. The purpose of this study was to determine factors associated with operative treatment for suspected benign tumors of the upper extremity.
Methods Treated by three different hand surgeons between July 2001 and July 2011, 1,593 tumors were identified using billing records. The measured variables were: sex, age, marital status, pain, neurovascular status, location of the tumor, bilateral involvement, preoperative diagnosis, prior surgeries in general, prior aesthetic surgery, prior tumor surgery in general, prior upper extremity tumors, prior upper extremity tumor surgery, prior surgery for same tumor, current or prior cancer, and number of visits before treatment. Variables associated with operative treatment were assessed in bivariate analysis and backwards elimination logistic regression analysis.
Results Factors that significantly increased the probability of surgery were a higher number of visits before treatment, giant cell tumors, treated by surgeon A, lipomas, tumors located on the finger, and prior upper extremity tumors. Factors that significantly decreased the probability of surgery were treated by surgeon B and retinacular/tendon sheath ganglion cysts. Prior or current cancer was not significantly associated with operative treatment.
Conclusions Tumor location, preoperative diagnosis, prior upper extremity tumor, and surgeon affect the likelihood of surgery for an upper extremity tumor.
Level of evidence: Prognostic II

Keywords Benign subcutaneous tumor · Ganglion cyst · Operative treatment · Upper extremity

H. C. E. Sluijmer · S. J. E. Becker · D. C. Ring (✉)
MGH Hand Surgery, Yawkey Center, Suite 2100,
Massachusetts General Hospital, 55 Fruit Street,
Boston, MA 02114, USA
e-mail: dring@partners.org

Introduction

Benign tumors of the upper extremity are common. Ganglion cysts account for 50 to 70 % of hand and wrist tumors with giant cell tumors of tendon sheath the second most common tumor [5, 11].

Tumors of the upper extremity are nearly always benign [7, 20] and mostly painless [11]. The majority of giant cell tumors of the tendon sheath and fibromas are not painful [6, 19]. It is thought that pain associated with a mucous cyst is probably due to osteoarthritis [19], but there is some difference of opinion when it comes to pain caused by ganglions with rates of pain reported between 26 and 100 % [1, 4, 5, 15, 17, 22, 24].

Surgery is usually elective and with up to 71 % of patients who are worried about unsightly appearance, it might even be considered aesthetic [1, 4, 8].

Westbrook et al. [24] noted the following reasons for patients to seek medical attention for a ganglion cyst: 38 % of patients did not like the appearance, 28 % were concerned about cancer, 26 % had pain, and 8 % had altered sensation or hand function. Seventy percent were specifically referred to a hand specialist for surgical excision, and 30 % for further advice and treatment.

There is no consensus on the treatment of suspected benign hand and arm tumors. Dias and Buch [2] found that at 2- and 5-year follow-up of patients treated for palmar wrist ganglia, there was no difference in post-treatment symptoms or satisfaction, regardless of the treatment (aspiration, excision, or reassurance only). Another study by Peters et al. [16] also found that operative treatment for hand and wrist ganglion cysts did not result in less pain intensity, less disability, or higher satisfaction compared to non-operative treatment. Leffert [8] concluded that the majority of lipoma excisions were done for aesthetic reasons. Besides the fact that patients trade their lump for a scar with surgery, there is also the possibility of recurrence [2, 13, 21],

adverse events, and disappointment (e.g. failure to improve comfort). Psychological factors were not associated with treatment choice for hand and wrist ganglion cysts in one study [16].

The aim of this retrospective study is to determine factors associated with operative treatment in a large cohort of patients diagnosed with a suspected benign tumor of the upper extremity. The objectives of this study are: (1) determine the factors associated with a choice of operative treatment for suspected benign tumors of the upper extremity; (2) determine the factors associated with not having surgery for a suspected benign tumors after a documented decision to proceed with surgery; (3) evaluate if pain influences the treatment decision of our surgeons; and (4) determine the number of diagnosed malignant tumors in our practice.

Materials and Methods

Patient Selection

Three thousand one hundred and sixty-seven patients diagnosed with one or more suspected benign tumors in a single practice between January 2001 and February 2012 were identified using billing records. Patients were included if they met the following criteria: (1) 18 years or older, (2) any benign subcutaneous tumor of the upper extremity, (3) consultation of one of three hand surgeons, and (4) first visit after June 2001 and before July 2011. Exclusion criteria were: (1) cutaneous tumors, (2) tumors due to a foreign body, (3) osteophytes/arthritis deformity, (4) suspected malignant tumors, (5) tenosynovitis, (6) epicondylitis, and (7) patients with a known condition of multiple tumors, e.g., neurofibromatosis, scleroderma, and sarcoidosis. This study was approved by our Human Research Committee.

During the study period, 13 suspected malignant tumors had operative treatment. These 13 patients were excluded from the analysis. Two of them had a malignant tumor: one soft tissue chondroblastic osteosarcoma; one high-grade pleomorphic fibroblastic/myofibroblastic sarcoma. Of the 1,543 patients, 1,593 tumors were included in the analysis. The cohort consisted of 1,012 women and 531 men with a mean age of 49±16 years (range, 18 to 92). Details of tumor type and location are presented in Table 1. Of the 1,593 analyzed tumors, 499 tumors had surgery as their first treatment. Fifty-six tumors received additional surgery. For 21 tumors, this was the second time they were surgically treated. In total, 534 tumors received operative treatment.

Chart Review and Definitions

The following variables were retrospectively recorded from the medical records: sex, age, marital status, location of the tumor, unilateral or bilateral involvement, pain, neurovascular symptoms, preoperative diagnosis, prior upper extremity tumor, prior upper extremity tumor surgery, prior surgery for same tumor, prior surgery in general, prior tumor surgery in general, prior aesthetic surgery, current or prior cancer, and number of visits before treatment (if patients received treatment at time of the first visit (e.g., aspiration or gel pad), this was recorded as no visits (0) before first treatment).

The location of tumors was divided into four groups: finger, hand, wrist, and arm. The preoperative diagnoses were divided into seven groups: wrist ganglion cyst, retinacular/tendon sheath ganglion cyst, ganglion cyst on the hand or finger not otherwise specified (not clear from the medical record what kind of ganglion cyst), mucous cyst, lipoma, giant cell tumor, and other tumors (e.g., schwannoma, glomus tumor, and vascular malformations).

We recorded the following variables from the medical history before patients' first visit to the practice: (1) Prior upper extremity tumor, defined as any prior upper extremity tumor, including the tumor for which the patient consulted one of our hand surgeons; (2) prior upper extremity tumor surgery, defined as prior surgical treatment for any upper extremity tumor, including the tumor for which the patient consulted one of our hand surgeons; (3) prior surgery for same tumor, defined as prior surgical treatment of the tumor for which the patient consulted one of our hand surgeons; (4) prior surgery in general, defined as any kind of surgery in the past; (5) prior tumor surgery in general, defined as prior surgery for either benign or malignant tumors; (6) prior aesthetic surgery, defined as any kind of cosmetic, but non-reconstructive, surgery in the past; and (7) current or prior cancer, including any kind of cancer, regardless of the cancer treatment.

The primary outcome was operative treatment. The following interventions were considered as conservative treatment: gel pad, splinting, injection, aspiration, and monitoring (this was only considered a treatment at the time of the last visit if a patient did not receive any other treatment in our practice before that time). Secondly, we looked at factors associated with not having surgery after a documented decision to proceed with surgery. Thirdly, we determined if pain was associated with treatment choice of the three surgeons. Finally, we determined the number of malignant tumors in our practice during 10 years.

Statistical Analysis

An a priori sample size analysis indicated that a sample size of 320 patients would provide 80 % statistical power to detect an odds ratio of 1.4 in the percentage of patients who underwent surgery (two-tailed alpha=0.05, beta=0.20) using logistic regression.

Pearson chi-square tests were used to determine the difference between two categorical variables. The Fisher's exact test was used instead if the minimum expected cell frequency

Table 1 Bivariate analysis—all benign upper extremity tumor treatments, n=1,593

	Conservative treatment vs. surgery							
	Conservative treatment n=1,059			Surgery n=534				
Parameter	Mean	SD	Range	Mean	SD	Range	Association	*P* value
Age (years)	49.5	16.6	18–92	49.1	15.9	18–89	NS	0.61
Number of visits before first treatment	0.34	0.76	0–7	1.3	0.91	0–8		*<0.001*
Parameter	Number		%	Number		%		
Sex							NS	0.88
Male	365		34.5	182		34.1		
Female	694		65.5	352		65.9		
Race							NS	0.23
White	851		80.4	423		79.2		
Black	47		4.4	31		5.8		
Hispanic	83		7.8	52		9.7		
Asian	55		5.2	18		3.4		
Other or unknown	23		2.2	10		1.9		
Marital status							NS	0.52
Single	243		22.9	140		26.2		
Living with partner	32		3.0	10		1.9		
Married	566		53.4	280		52.4		
Separated/divorced	94		8.9	43		8.1		
Widow	49		4.6	21		3.9		
Uknown	75		7.1	40		7.5		
Surgeon								*<0.001*
Surgeon A	223		21.1	251		47.0		
Surgeon B	322		30.4	70		13.1		
Surgeon C	514		48.5	213		39.9		
Location								*0.015*
Finger	447		42.2	241		45.1		
Hand	125		11.8	55		10.3		
Wrist	447		42.2	201		37.6		
Arm	40		3.8	37		6.9		
Symptomatic side							NS	0.14
Unilateral	1,043		98.5	531		99.4		
Bilateral	16		1.5	3		0.6		
Pain							NS	0.13
No	780		73.7	374		70.0		
Yes	279		26.3	160		30.0		
Neurovascular symptoms							NS	0.30
No	1,035		97.7	526		98.5		
Yes	24		2.3	8		1.5		
Preoperative diagnosis								*<0.001*
Ganglion, not otherwise specified	159		15.0	63		11.8		
Lipoma	20		1.9	30		5.6		
Giant cell tumor	8		0.8	34		6.4		
Wrist ganglion	428		40.4	191		35.8		
Mucous cyst	106		10.0	53		9.9		
Retinacular/tendon sheath ganglion cyst	141		13.3	25		4.7		
Other	197		18.6	138		25.8		

Table 1 (continued)

	Conservative treatment vs. surgery							
	Conservative treatment n=1,059			Surgery n=534				
Parameter	Mean	SD	Range	Mean	SD	Range	Association	P value
Prior upper extremity tumor								*<0.001*
No	942		89.0	435		81.5		
Yes	117		11.0	99		18.5		
Prior upper extremity tumor surgery								*0.0013*
No	991		93.6	475		89.0		
Yes	68		6.4	59		11.0		
Prior surgery for same tumor								*0.010*
No	1,020		96.3	499		93.4		
Yes	39		3.7	35		6.6		
Prior surgery in general								*0.034*
No	355		33.5	151		28.3		
Yes	704		66.5	383		71.7		
Prior tumor surgery in general								*0.0087*
No	786		74.2	363		68.0		
Yes	273		25.8	171		32.0		
Prior aesthetic surgery								*0.013*
No	1,013		95.7	495		92.7		
Yes	46		4.3	39		7.3		
Current or prior cancer							NS	0.84
No	905		85.5	456		85.4		
Prior	143		13.5	74		13.9		
Current	11		1.0	4		0.7		

N number, *SD* standard deviation, *NS* not significant

Italics indicates statistical significance

was less than five. Student's t tests were conducted to determine the difference between continuous and dichotomous variables. All variables with significant ($P<0.05$) or near significant ($P<0.10$) relationships in the bivariate analysis were entered in a multivariable logistic regression analysis using the backwards conditional method to assess factors possibly associated with surgery. Categorical variables were transformed into dummy-coded variables so that they could be entered into the logistic regression analysis. A P value of <0.05 was considered statistically significant.

Results

Predictors of Operative Treatment

A higher number of visits before treatment, surgeon, tumor localization, preoperative diagnosis, prior upper extremity tumor, prior upper extremity tumor surgery, prior surgery for the same tumor, prior surgery in general, prior tumor surgery in general, and prior aesthetic surgery were significantly associated with undergoing operative treatment for benign tumors of the upper extremity (Table 1). The best logistic regression model explained 47 % of the variance in undergoing operative treatment for benign upper extremity tumors (Table 2). Factors included in the model that significantly increased the probability of surgery in the best logistic regression model were a higher number of visits before treatment, giant cell tumors, treated by surgeon A, lipomas, tumors located on finger, and prior upper extremity tumors. Factors included in the model that significantly decreased the probability of surgery were treated by surgeon B and retinacular/tendon sheath ganglion cysts.

Predictors of Not Having Surgery After a Documented Plan for Surgery

Of the 572 patients who elected to have surgery, 73 had no documented operative treatment (13 %). Surgeon was the

Table 2 Multivariable analysis—predictors of surgery, $n=1,593$

Predictors which increase the probability of surgery	*P* value	Odds ratio		95 % CI for odds ratio	
				Lower	Upper
Number of visits before first treatment	*<0.001*	5.2		4.3	6.3
Giant cell	*0.010*	3.3		1.3	8.3
Surgeon A	*<0.001*	2.9		2.1	3.8
Lipoma	*0.044*	2.2		1.0	4.7
Location—finger	*<0.001*	1.7		1.3	2.3
Prior upper extremity tumor	*0.035*	1.5		1.0	2.1
Predictors which decrease the probability of surgery	*P* value	Odds ratio	Reversed odds ratio	95 % CI for odds ratio	
				Lower	Upper
Surgeon B	*<0.001*	0.2	5.1	0.1	0.3
Retinacular/tendon sheath ganglion cyst	*0.037*	0.6	1.8	0.3	1.0

Italics indicates statistical significance

only significant predictor for not having surgery after a decision for operative treatment ($p=0.0058$). Patients with surgeons with lower operative rates had higher rates of changing their mind: 22 % of patients treated by surgeon B changed their mind and opted not to have surgery compared to 9 % for surgeon A and 14 % for surgeon C (Table 3).

Pain as a Predictor for Treatment Choice of the Three Surgeons

Of the 1,593 tumors, 439 were associated with pain. For two surgeons, pain was significantly associated with a decision for operative treatment. For the third surgeon, pain did not affect the decision for surgery (Table 4).

Malignant Tumors

Among 1,593 suspected benign tumors evaluated during the study period, there was one malignancy (an aggressive digital papillary adenocarcinoma over the A1 pulley of the index finger and thought to be a large retinacular ganglion cyst or giant cell tumor). This represents 0.063 % of all tumors and 0.19 % of operatively treated tumors. Combined with 13 suspected malignancies (which were excluded from this analysis), there were three malignancies among all 1,606 tumors (0.19) during the study period.

Discussion

The aim of this study was to determine factors associated with operative treatment for suspected benign tumors of the upper extremity. We rejected our primary null hypothesis, finding that tumor location, preoperative diagnosis, prior upper extremity tumor, and surgeon affect the likelihood of surgery for an upper extremity tumor. The treating surgeon was the only predictor for not proceeding with surgery after document decision for operative treatment. Overall, pain was not associated with undergoing surgery, but it was a predictor for operative treatment in two out of three surgeons. Although seeking a doctor's advice for a ganglion cyst has been associated with concern for cancer [24], prior or current cancer was not significantly associated with operative treatment in our population. Our study was consistent with prior observations that benign tumor surgery may be related to aesthetic concerns [8], given that the probability of operative treatment was increased when a patient had prior aesthetic surgery.

The strengths of this study were the large number of patients and the long period (10 years) of study. The limitations of this study were inherent to the retrospective study design. We cannot be sure whether some patients had operative treatment elsewhere. Likewise, it is not certain if the medical history, interview, and physical exam were completely documented in the medical record. Finally, practice style is clearly important and we only evaluated three different surgeons.

Other than number of visits prior to surgery and bilateral involvement, the surgeon was the strongest factor associated with surgery or no surgery. It is well recognized that there is unwarranted variation in medicine, a great deal of which relates to variations in rates of elective operative treatment in different regions or by different surgeons [12, 18]. Recent studies on the management of idiopathic trigger fingers and trapeziometacarpal arthrosis also found substantial differences by surgeon [9, 14]. The patient's influence in the decision-making is manifested in the aesthetic and prior surgery factors, but it appears that surgeon factors (including tumor location and suspected diagnosis) have a stronger influence on decision for operative treatment than patient factors. The observation that the relationship of preoperative pain to decision for surgery varied between surgeons, combined with the observation that surgeon was the only risk

Table 3 Bivariate analysis—all patients that elected operative treatment, $n=572$

Parameter	Surgery vs. no show for surgery							
	Surgery $n=499$			No show $n=73$				
	Mean	SD	Range	Mean	SD	Range	Association	*P* value
Age (years)	48.8	15.7	18–89	48.5	14.5	20–84	NS	0.87
Number of visits before first treatment	1.4	0.9	0–8	1.5	0.8	0–5	NS	0.72
Parameter	Number		%	Number		%		
Sex							NS	0.58
Male	324		64.9	45		61.6		
Female	175		35.1	28		38.4		
Race							NS	0.58
White	391		78.4	58		79.5		
Black	31		6.2	7		9.6		
Hispanic	50		10.0	6		8.2		
Asian	17		3.4	2		2.7		
Other or unknown	10		2.0	0		0.0		
Marital status							NS	0.86
Single	133		26.7	16		21.9		
Living with partner	9		1.8	1		1.4		
Married	261		52.3	39		53.4		
Separated/divorced	41		8.2	9		12.3		
Widow	19		3.8	3		4.1		
Uknown	36		7.2	5		6.8		
Surgeon								*0.0058*
Surgeon A	222		44.5	21		28.8		
Surgeon B	68		13.6	19		26.0		
Surgeon C	209		41.9	33		45.2		
Location							NS	0.55
Finger	226		45.3	28		38.4		
Hand	54		10.8	7		9.6		
Wrist	182		36.5	33		45.2		
Arm	37		7.4	5		6.8		
Symptomatic side							NS	0.42
Unilateral	496		99.4	72		98.6		
Bilateral	3		0.6	1		1.4		
Pain							NS	0.59
No	347		69.5	53		72.6		
Yes	152		30.5	20		27.4		
Neurovascular symptoms							NS	0.37
No	491		98.4	71		97.3		
Yes	8		1.6	2		2.7		
Preoperative diagnoses							NS	0.30
Ganglion, not otherwise specified	54		10.8	9		12.3		
Lipoma	30		6.0	1		1.4		
Giant cell tumor	34		6.8	3		4.1		
Wrist ganglion	172		34.5	33		45.2		
Mucous cyst	49		9.8	7		9.6		
Retinacular/tendon sheath ganglion cyst	24		4.8	1		1.4		
Other	136		27.3	19		26.0		

Table 3 (continued)

Parameter	Surgery vs. no show for surgery							
	Surgery *n*=499			No show *n*=73				
	Mean	SD	Range	Mean	SD	Range	Association	*P* value
Prior upper extremity tumor							NS	0.85
No	408		81.8	59		80.8		
Yes	91		18.2	14		19.2		
Prior upper extremity tumor surgery							NS	0.66
No	446		89.4	64		87.7		
Yes	53		10.6	9		12.3		
Prior surgery for same tumor							NS	0.35
No	466		93.4	66		90.4		
Yes	33		6.6	7		9.6		
Prior surgery in general							NS	0.59
No	145		29.1	19		26.0		
Yes	354		70.9	54		74.0		
Prior tumor surgery in general							NS	0.85
No	343		68.7	51		69.9		
Yes	156		31.3	22		30.1		
Prior aesthetic surgery							NS	0.81
No	462		92.6	67		91.8		
Yes	37		7.4	6		8.2		
Current or prior cancer							NS	0.68
No	431		86.4	64		87.7		
Prior	65		13.0	8		11.0		
Current	3		0.6	1		1.4		

N number, *SD* standard deviation, *NS* not significant

Italics indicates statistical significance

Table 4 Affect of pain on treatment decision for different surgeons, *n*=1,593

	Treatment					
	Non-operative treatment *n*=1,059		Operative treatment *n*=534			
Parameter	Number	%	Number	%	Association	*P* value
Surgeon A (*n*=474)						*0.0072*
No pain	190	85.2	189	75.3		
Pain	33	14.8	62	24.7		
Surgeon B (*n*=392)						*0.014*
No pain	236	73.3	41	58.6		
Pain	86	26.7	29	41.4		
Surgeon C (*n*=727)					NS	0.74
No pain	354	68.9	144	67.6		
Pain	160	31.1	69	32.4		

N number, *NS* not significant

Italics indicates statistical significance

factor for deciding not to have surgery after an initial decision for surgery, also emphasize the strong influence of practice style on the rate of operative treatment for suspected benign tumors of the upper extremity.

Primary malignancies are considered rare in the upper extremity, particularly below the elbow. Of the 1,593 suspected benign tumors, we encountered one malignancy (0.063 %). Very few cases in our cohort were referrals from other surgeons (i.e., our cohort is representative of primary care referrals). In any case, we are not confident that this data set can be used to determine the incidence of malignancy among suspected benign tumors. Given the rarity of such tumors, only 85 cases of aggressive digital papillary carcinoma had been reported in the literature in 2009 [3], this single unsuspected malignancy might be spurious and our data do reinforce the possibility of malignancy, even when the surgeon does not suspect it.

While there is no correct rate of surgery, surgeon A increased the chance of surgical treatment and surgeon B decreased the chance with respect to surgeon C. Patients treated by surgeon B were least likely to choose surgery and more likely to change their mind and decide not to have surgery after an initial plan to have surgery. This suggests that surgeon B explained the problem in a way that made non-operative treatment more appealing both at the time of initial decision and upon reflection after deciding on surgery. Decision aids are intended to place greater emphasis on patient preferences and may decrease surgeon-to-surgeon variations in care [12]. As in quality control and manufacturing, variations in care that cannot be accounted for by differences in pathophysiology or other objective evidence (unexplained or unwarranted variation [12, 23]) may indicate opportunities for process improvement. This means that the differences in surgery rate among the various surgeons should ideally be limited, without implying that there is a correct rate of surgery. Evidence to date suggests that patients considering discretionary surgery are less likely to choose surgical treatment when they are provided with decision aids [10, 12]. Future research will define the role of decision aids in the management of suspected benign tumors of the upper extremity.

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Ethical statement All authors adhere to the ethical standards described by the Committee on Publication Ethics and the International Committee of Medical Journal Editors. The study was completed under an IRB-approved protocol.

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